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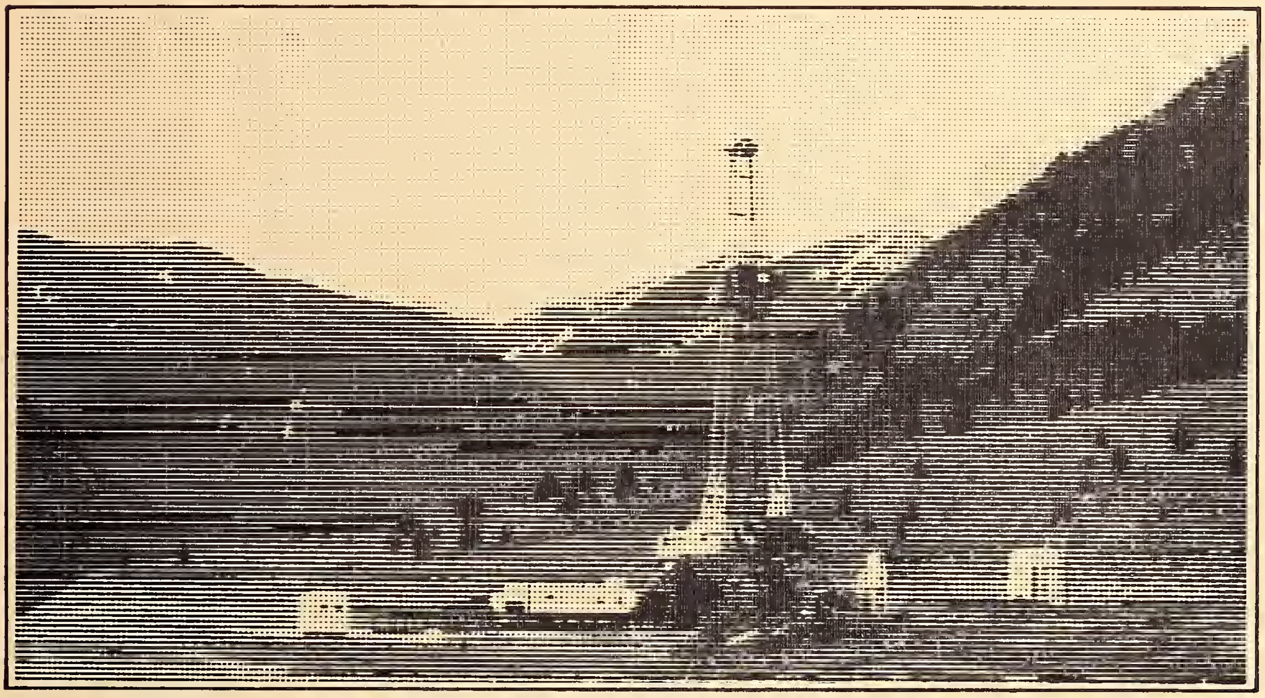
AMOCO BEARTOOTH WELL EXPLORATION PROJECT



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ENVIRONMENTAL ASSESSMENT
AMOCO PRODUCTION COMPANY'S
PROPOSED BEARTOOTH EXPLORATION WELL

Prepared by:

Dames & Moore
Fort Collins, Colorado

Prepared for:

Bureau of Land Management
Miles City, Montana

and

Amoco Production Company
Denver, Colorado

May 1986

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CHAPTER ONE

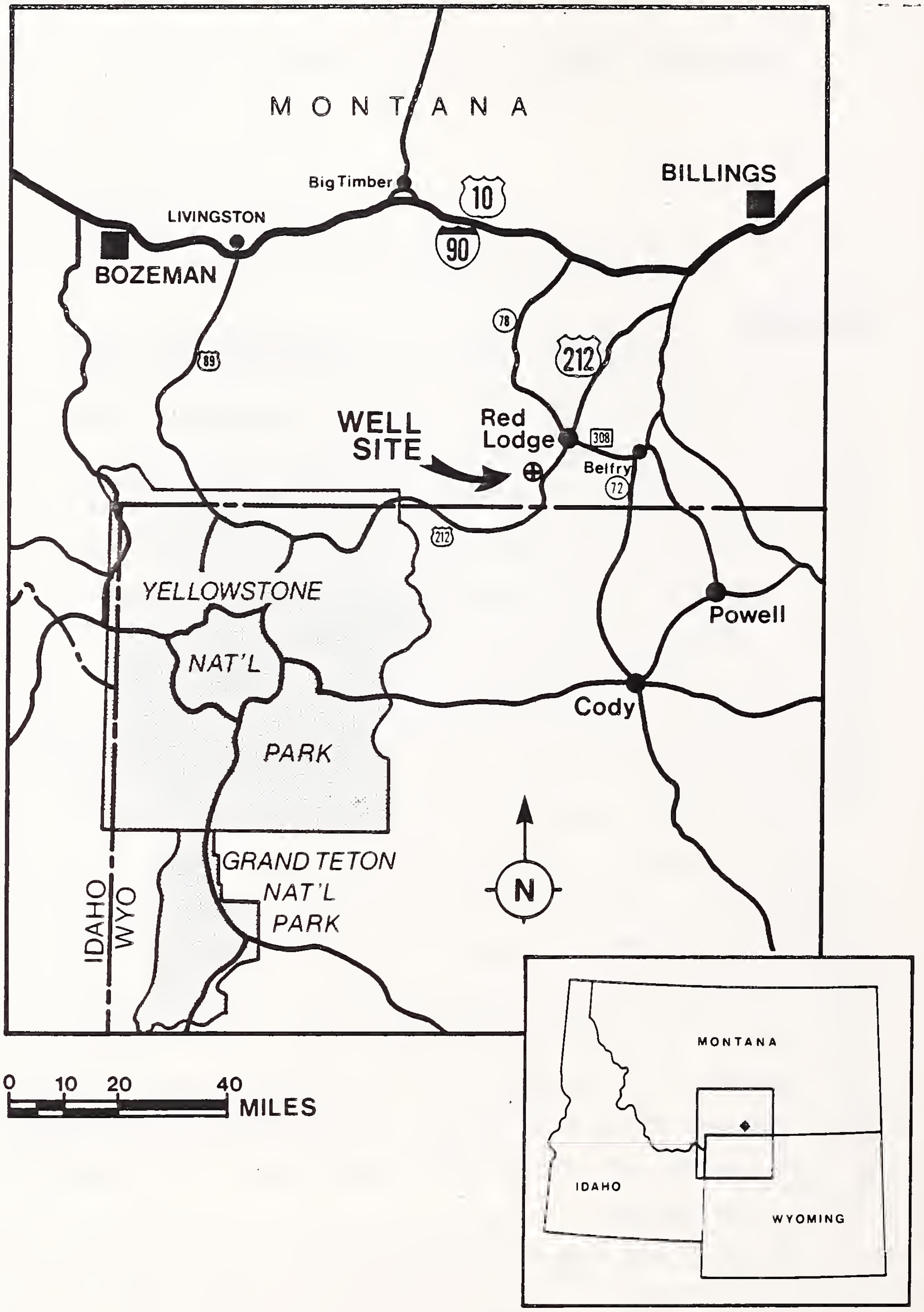
INTRODUCTION

BACKGROUND

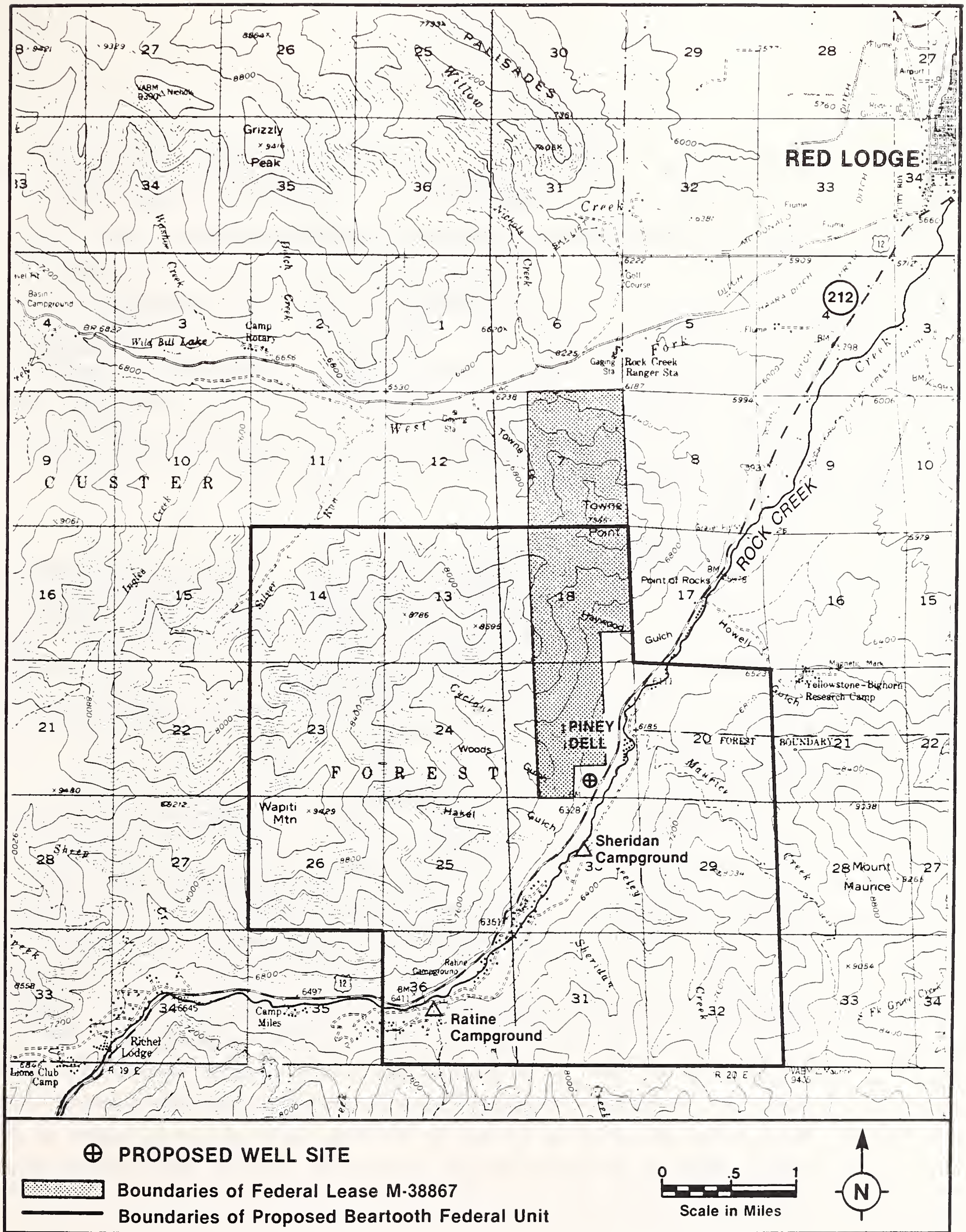
This Environmental Assessment (EA) analyzes the environmental impacts of a wildcat oil and gas well proposed by Amoco Production Company (Amoco) near Red Lodge, Carbon County, Montana (Map 1-1). Amoco's Beartooth Well Exploration Project is proposed to explore and test the hydrocarbon production potential of Federal Minerals Lease M-38867, issued by the Bureau of Land Management (BLM) in 1979. Federal Minerals Lease M-38867 is one of several federal and private oil and gas leases which have been incorporated into the proposed Beartooth Federal Unit (Map 1-2), based on geological characteristics of potential hydrocarbon-producing formations. Amoco has been designated Operator of the proposed Beartooth Federal Unit and will be responsible for conducting exploration activities within the Unit boundary.

The proposed project involves construction of a 2.2 acre well pad; drilling of a single exploration well; production testing of hydrocarbon bearing formations (if found); and restoration and abandonment of the site. The proposed project would be located on private land near Highway 212, just east of the Custer National Forest. The drilling target, or bottom-hole location, is inside the Forest boundary, approximately 2,000 feet from the proposed surface location. Amoco will file an application with the Montana Board of Oil and Gas Conservation for approval of the proposed wellbore deviation.

Because BLM has jurisdiction over the minerals in the area of the proposed drilling, Amoco is required to obtain BLM review and approval of its proposal. Amoco submitted a complete permit application package to the BLM Miles City District Office in November, 1985, including an Application for a Permit to Drill (APD), a Drilling Plan, and a Surface Use Plan. On the basis of public interest and concern expressed over the drilling program, BLM decided to prepare this EA to provide full discussion and



Map 1-1 Project Location



Map 1-2 General Study Area

disclosure of the environmental impacts and public issues associated with the proposed project. The EA, and public comments obtained during the environmental assessment process, will assist BLM in its review of Amoco's APD.

At this time, Amoco is seeking federal and state approvals (Table 1-1) only for drilling and production testing of a single exploratory well. If further development is warranted based on the results of the exploratory drilling program, proposed facilities would require separate permit applications and further environmental review under the National Environmental Policy Act (NEPA) and applicable state requirements.

INTERRELATIONSHIPS

Full development of federal oil and gas leases normally proceeds through five phases: Leasing; Geophysical Exploration; Exploratory Drilling; Development and Production; and Abandonment (BLM 1981). Each phase in the overall process is subject to environmental analysis under NEPA and BLM review and approval of proposed activities. Amoco's proposed Beartooth Well Exploration Project is an intermediate step in the overall process defined by the BLM.

Amoco is proposing to evaluate the hydrocarbon potential of a federal minerals lease issued by the BLM in 1979. Proposed activities are constrained by the conclusions of environmental analyses completed prior to leasing. Since the U.S. Forest Service (USFS) has surface management responsibility for the land included in the federal minerals lease, the environmental impacts of leasing were evaluated in the USFS's *Land Management Plan for the Beartooth Face Planning Unit* (USFS 1978a). Amoco's proposed exploration well conforms to special stipulations that were attached to the lease based on the USFS's environmental review. In particular, a "No Surface Occupancy" stipulation in the federal minerals lease lead to Amoco's proposal to conduct drilling activities from nearby private land, using directional drilling techniques to reach the drilling target inside USFS boundaries.

TABLE 1-1

AUTHORIZING ACTIONS FOR THE PROPOSED BEARTOOTH EXPLORATION WELL

AGENCY	AUTHORIZING ACTION	STATUS
Federal		
Bureau of Land Management	Approval of Application for Permit to Drill, Drilling Plan, and Surface Use Plan	Application submitted. BLM decision depends on review of this EA.
Fish and Wildlife Service	Endangered Species Act Compliance	Assessment of endangered species concerns is included in this EA.
State		
Oil & Gas Conservation Board	Notification of Intent to Drill	Submitted and approved.
	Approval for Deviating the Wellbore	Will be submitted.
Department of Highways	Access Approach Permit	Application pending State approval.
Department of Natural Resources & Conservation	Groundwater Appropriation Permit	Application pending State approval.
State Historic Preservation Officer/BLM	Antiquities Act Compliance	Submitted.

If approved by BLM, drilling activities currently proposed by Amoco may also be subject to additional stipulations attached to the APD, if the need is demonstrated. Similarly, if future proposals for additional wells or production facilities are forthcoming, they will be reviewed by BLM and appropriate environmental analyses will be conducted.

SCOPE OF ANALYSIS

Analyses in the main body of the EA are restricted to the potential environmental impacts associated with Amoco's proposed exploration well, including the effects of wellpad construction; exploratory drilling activities; production testing; and site restoration. Analyses include the direct effects of these activities at and near the proposed well site and the indirect environmental effects expected within a larger study area surrounding the proposed well (Map 1-2). Based on public scoping and an informational meeting held to solicit input, important issues to be addressed in the EA include the following:

* Health and Safety Aspects of the Drilling Program;
* Noise Levels from Drilling;
* Visual Impacts of the Drilling Rig;
* Impacts on Water Quality in Rock Creek;
* Impacts on Recreational Uses of the Rock Creek Valley;
* Impacts on the Silver Run Elk Herd;
* Disruption of Area Traffic; and
* Socioeconomic Impacts of the Exploration Project.

Potential cumulative effects of additional exploration wells, future production wells, and associated oil and gas production facilities, were also identified as an important area of concern during the public scoping process. These activities are not part of the Proposed Action considered in the EA and no decision concerning future development will be made by the BLM at this time. However, it is recognized that additional development proposals within the proposed Beartooth Federal Unit may be expected if commercial quantities of oil and gas are discovered through Amoco's Beartooth Exploration Well. To help orient readers to the possibilities for future field development, **Appendix A** provides a general discussion of the facilities, geographic area, and environmental review process associated with future development.

Detailed environmental analyses of field development would be completed once the characteristics of the oil and gas resource are sufficiently defined to allow reasonable assumptions to be made regarding the nature and extent of needed development and production facilities. As directed by BLM Policy (BLM Handbook H-3160-1, dated February 2, 1984) and existing legal precedents, such analyses are required prior to drilling a confirmation well after an oil or gas discovery. When completed, these analyses would provide a thorough evaluation of all impacts associated with full development of the proposed Beartooth Federal Unit.

PURPOSE AND NEED

The purpose of Amoco's proposed Beartooth Well Exploration Project is to determine the hydrocarbon potential of Federal Minerals Lease M-38867, issued by the BLM in 1979.

Private exploration and development of federal oil and gas leases is an integral part of the BLM's oil and gas leasing program under authority of the Mineral Leasing Act of 1920 and the Federal Land Policy and Management Act of 1976. The overall oil and gas leasing program is needed to encourage development of domestic oil and gas reserves to reduce the United States' dependence on foreign energy supplies. Despite decreases in per capita energy consumption since the mid-1970s, the United States continues to rely heavily on foreign energy sources. The U. S. Energy Information Administration (1984) projects that by 1990 the United States will continue to import approximately 38 percent (6.4 million barrels per day) of its domestic petroleum needs and 5 percent (0.8 trillion cubic feet per year) of its domestic natural gas needs.

CHAPTER TWO

PROPOSED ACTION AND ALTERNATIVES

PROPOSED ACTION

The following description of the proposed Beartooth Exploration Well Project was summarized from Amoco's November 1985 APD, Drilling Program (10 point plan), Surface Use Plan (13 point plan), and additional information provided by Amoco.

Location

Amoco's proposed exploration well, officially designated as the USA Amoco A #1 Well, would be drilled from a well pad proposed for construction in Section 19, Township 8 South, Range 20 East, in Carbon County, Montana approximately 4.5 miles south of Red Lodge (Maps 1-1 and 1-2). The well pad boundary would be approximately 60 ft. west of Montana Highway 212; the wellbore would be located about 235 ft. from the highway.

The site is located on private land approximately 1,000 ft. east of the Custer National Forest boundary. Directional drilling techniques would be used to reach a bottomhole location inside the Forest boundary. The federal minerals lease allowing oil and gas exploration stipulates no surface occupancy (NSO) of the Forest Service land over the proposed drilling target.

Wellpad Construction

All surface activities associated with the proposed Beartooth Well Exploration Project would be confined to a 260 ft. by 375 ft. (2.2 acre) wellpad (Figure 2-1). Most of the area occupied by the wellpad consists simply of a level area which provides a stable surface for erection of the drilling rig and other temporary facilities. Other features of the wellpad include the following:

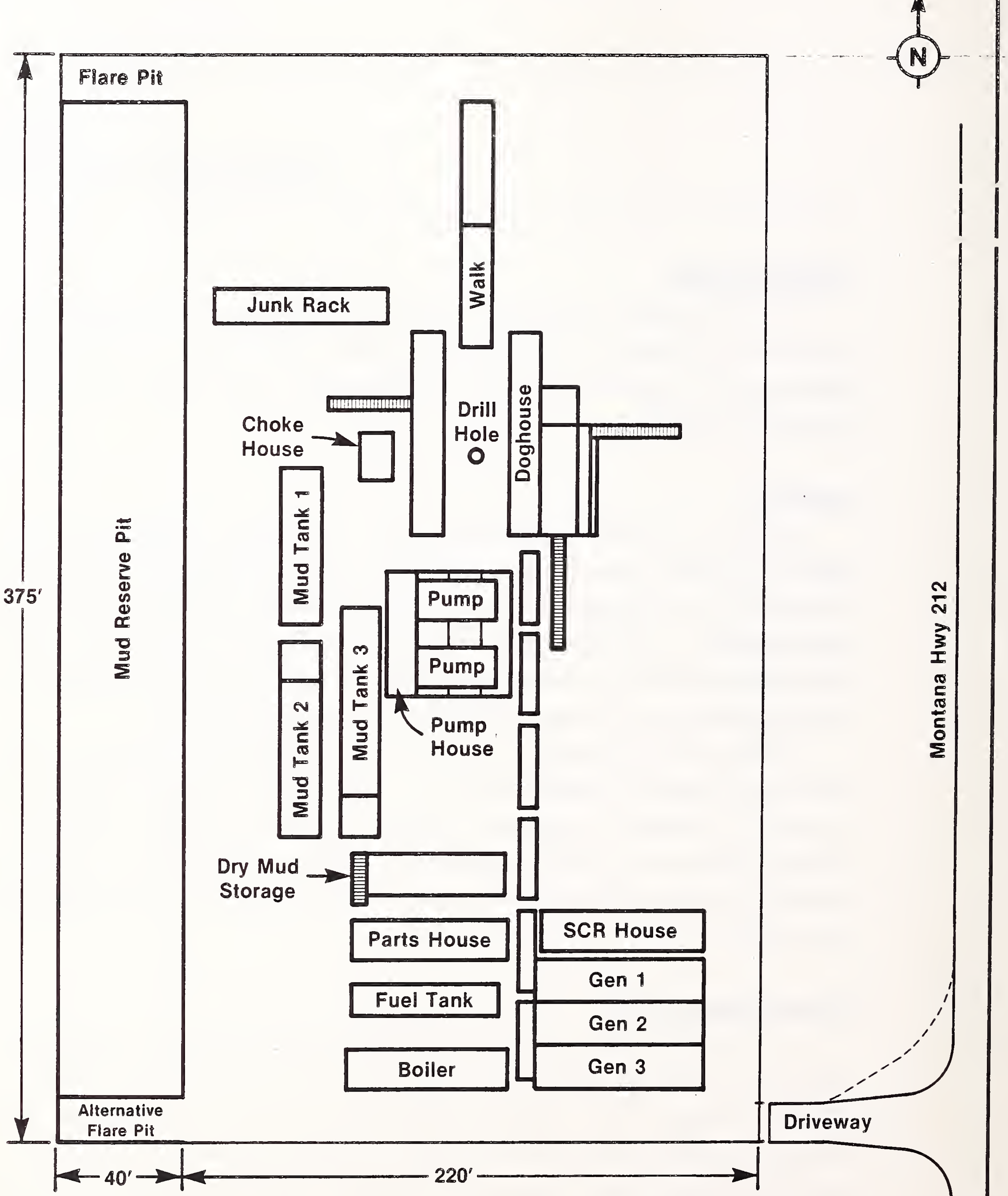


Figure 2-1 Typical Drill Site Layout

Not to scale

- Mud Reserve Pit. A pit would be excavated to temporarily store drilling fluids, cuttings, and water produced during drilling. To prevent seepage, the reserve pit would be lined with a six-inch layer of bentonite overlaid by a 12 mil impermeable liner.

- Septic Tank. A septic tank would be installed on location to contain and treat sewage.

- Water Well. A water well would be drilled on-site to provide water for drilling operations. The capacity of the pump installed would not exceed 100 gallons per minute.

- Driveway. An existing driveway approach from State Highway 212 would be widened to provide access to the well site. The driveway improvement would be constructed using earth materials on-site and surfaced with gravel obtained from a commercial source. The driveway improvement would disturb approximately 0.1 acre.

Wellpad construction would require approximately one week. At the beginning of construction, the wellpad site would be cleared of vegetation. Approximately six inches of topsoil would then be stripped from the site and stockpiled for use in future reclamation. The wellpad would then be constructed using standard cut-and-fill construction techniques and construction machinery (i.e., D8 or D9 caterpillar tractor; backhoe for installing the septic tank; and a truck mounted water well drilling rig). Most of the construction materials for the wellpad would be obtained on-site. Bentonite and lining materials for the mud reserve pit and gravel for surfacing the driveway would be trucked to the site. Construction activities would disturb an additional 0.45 acre of land for cut-and-fill slopes; thus the total surface disturbance for the site would be approximately 2.75 acres.

Exploratory Drilling

Once site preparation work is complete, Amoco would begin the exploratory drilling phase of the project. A drilling rig would be transported to the wellpad by truck (Table 2-1) and erected on-site. Construction, or "rigging-up" typically requires approximately three days. The wellpad

TABLE 2-1
ESTIMATED TRANSPORTATION REQUIREMENTS FOR THE PROPOSED BEARTOOTH EXPLORATION WELL

TYPE OF TRAFFIC	FREQUENCY	LOADED VEHICLE WEIGHT (LBS)
Rig Transport and Rig-Up Operations		
Rig transport vehicles	13/day	80,000
Drilling Activities		
Rig crews	3/day	6,000
Rig mechanic	1/week	7,000
Amoco supervisor	2/day	4,000
Amoco geologist	2/day	4,000
Fuel truck	3/week	18,000
Mud truck	1/12 days	80,000
Mud engineers	1/day	4,000
Drilling engineer	1/day	4,000
Drill bit deliveries	2/week	4,000
DST trucks	3/well	18,000
Casing haulers	9/well	80,000
Cementers, pump truck	3/well	46,000
Cementers, cement truck	6/well	90,000
Cementers, engineer's PU	6/well	6,000
Loggers, logging truck	2/well	40,000
Loggers, engineer's car	4/well	4,000
Casing crew	3/well	17,000
Sprinkler truck	1/day	35,000
Miscellaneous supplies	2/week	8,000
Welder	1/week	17,000
Production Testing (if hydrocarbons are found)		
Completion, unit rig	1/well	75,000
Completion, equipment truck	1/well	20,000
Completion, crew pickup	1/day	7,000
Completion, pusher	3/week	6,000
Amoco supervisor	2/well	4,000
Tubing trucks	2/well	75,000
Service tools	2/week	16,000
Loggers, logging truck	1/week	40,000
Loggers, engineer's car	2/week	4,000
Anchor, installation truck	1/well	15,000
Anchor, testing truck	1/well	10,000
Test tank trucking	4/well	60,000
Acidizing, pump truck	1/well	46,000
Acidizing, acid truck	1/well	40,000
Acidizing, engineer's car	2/well	4,000
Fracing, pump trucks	4/well	70,000
Fracing, blender	1/well	35,000
Fracing, chemical trucks	2/well	35,000
Fracing, sand trucks	2/well	90,000
Fracing, engineer's car	2/well	4,000
Sprinkler truck	1/day	35,000
Miscellaneous supplies	2/week	8,000
Pumping/tank battery	5/well	80,000
Roustabout crew	1/day	7,000
Welder	5/well	17,000
Water truck	1/day	NA

layout for the drilling period would be similar to that shown on Figure 2-1 (see **Glossary** for definition of terms). Figure 2-2 shows the proposed drilling site with the components of a typical drilling rig in place. The simulated view of the drilling location was prepared by overlaying a typical drilling rig onto a recent photograph of the site.

The primary function of the drilling rig is to drill a hole to a specified depth. The various components of the drilling rig serve six functional roles, as specified below:

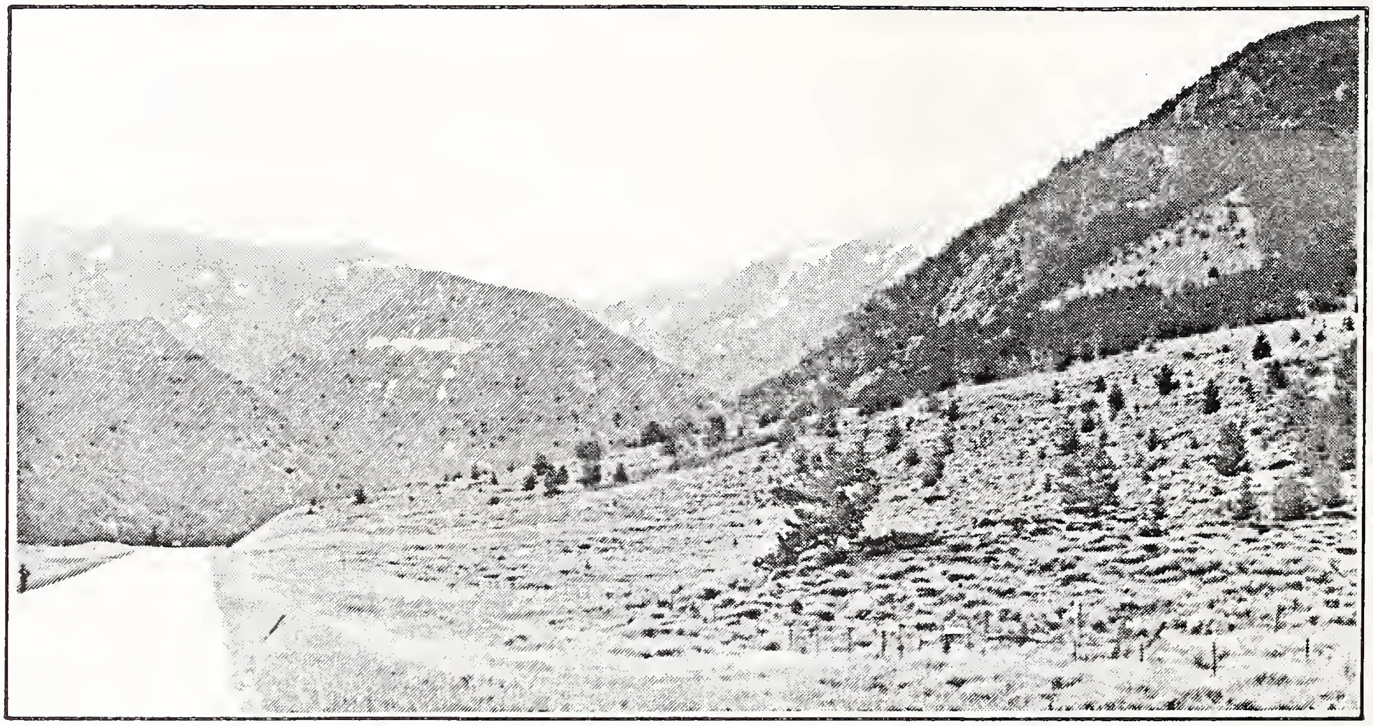
* Power System. Power for the drilling operation would be provided by a diesel-electric power system. A series of diesel-fueled generators would be used to generate electricity which would power the drilling rig, water well pump, mud pumps, and other operating systems.

* Hoisting System. The hoisting system consists of the tall (about 165 feet high) tower-like structure or mast and machinery installed on the mast to raise and lower the drill string and other equipment.

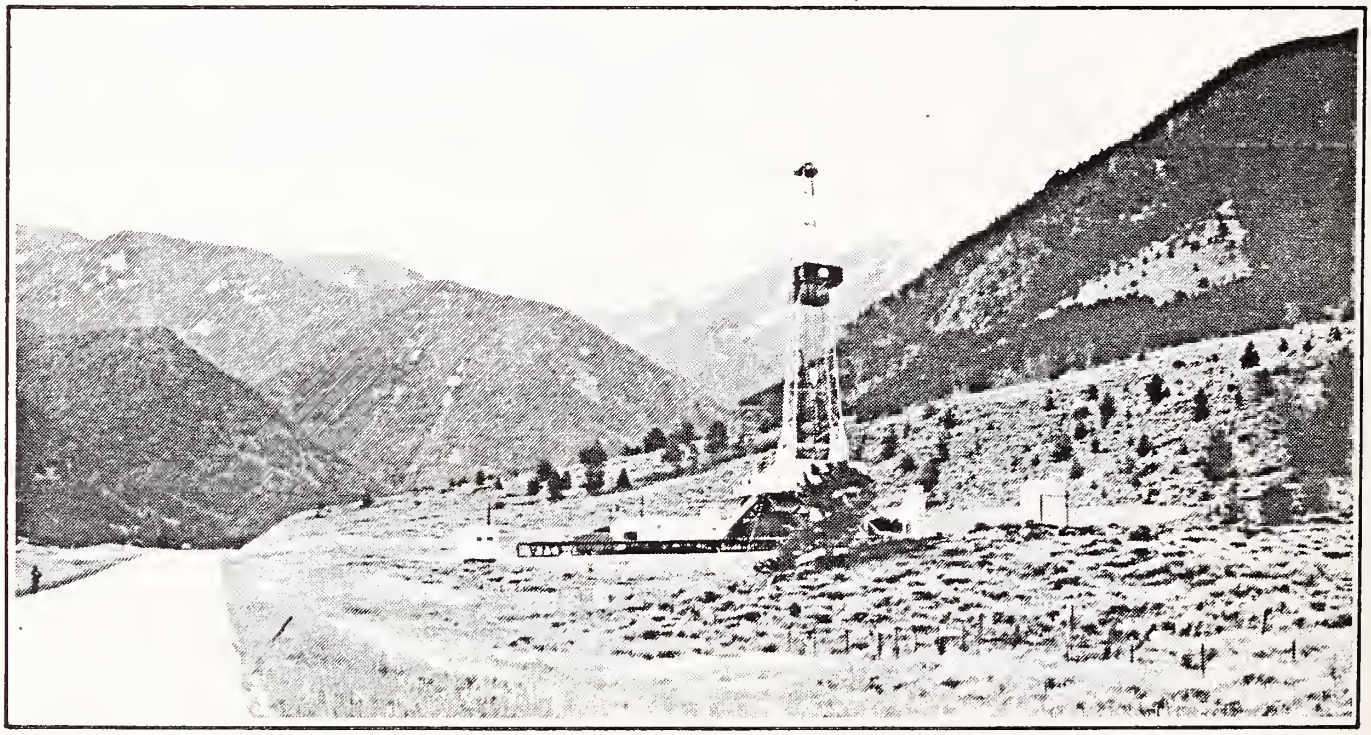
* Rotating Equipment. The actual drilling of the hole is accomplished by a drill bit rotating against subsurface formations. The rotating equipment includes the drill bit, which is changed periodically during drilling; the drill string, steel pipe which extends the drill bit into the hole; and the rotary, the machinery which turns the drill string and bit.

* Circulation System. Drilling fluids, or muds, are used to lubricate the drilling surface, raise cuttings made by the drill bit to the surface, and help control underground pressure in the well. The muds proposed for use in the Beartooth project would be composed primarily of water and bentonite, with soda ash, caustic soda, polyacrylate and polyacrylamide polymers, and other minor additives. The circulation system pumps mud from the mud tanks, down the drill string into the well, and returns it to the surface where it is recycled into the mud tanks or disposed in the mud reserve pit. Water for the mud system would be obtained from the ground water well. Water requirements are estimated to average approximately 10,000 gallons per day during the five-month drilling period.

* Well Pressure Control. The density of the drilling mud is adjusted during drilling to balance downhole pressures and prevent formation fluids (gas, water, or oil) from entering the wellbore



Existing site condition



Site with drilling rig in place

Figure 2-2 Visual Simulation of Proposed Drilling Site

and flowing to the surface. The drilling rig would also be equipped with blowout preventers which would be used to direct the flow to the flare pits or seal in the top of the well, if abnormally high pressure situations occur during drilling which cannot be controlled by drilling mud weight.

- Ancillary Facilities. Other ancillary facilities include equipment storage areas and several trailers which would be used as laboratory, office, and crew facilities.

Amoco proposes to drill the exploration well to test the Madison Formation to a total depth of approximately 15,000 ft. As the well is progressively deepened, steel casing would be installed in the well and cemented in place to: (1) prevent the sides of the wellbore from collapsing or caving, (2) protect against abnormal pressure conditions, and (3) protect freshwater and other mineral bearing formations. Potential hydrocarbon producing formations, or pay zones, would be evaluated during the drilling program. Drill cuttings would be examined for evidence of hydrocarbons. Various well logging techniques would be used to measure the properties of the geologic formations intersected and allow interpretation of the potential existence and quantity of hydrocarbons. Drill-stem testing may also be used during drilling to evaluate the hydrocarbon potential.

Amoco estimates that exploratory drilling activities would require approximately 150 days to complete. Amoco has proposed a fall-winter drilling season (Figure 2-3), with drilling beginning after Labor Day and ending in March. Drilling activities would be conducted continuously 24 hours a day, 7 days a week during the estimated period.

The exploratory drilling program would be conducted by a drilling contractor hired by Amoco. A contractor has not been selected, but it is expected that the contractor would supply crews based in Billings, Montana or Cody or Powell, Wyoming. With the exception of 6 key personnel required to be on-site at all times (Table 2-2), employees are expected to commute from Billings, Cody, or Powell. Some support services may be obtained from Red Lodge.

Employment requirements for the drilling operations are summarized in Table 2-2. During normal drilling operations, 10 to 12 persons would be

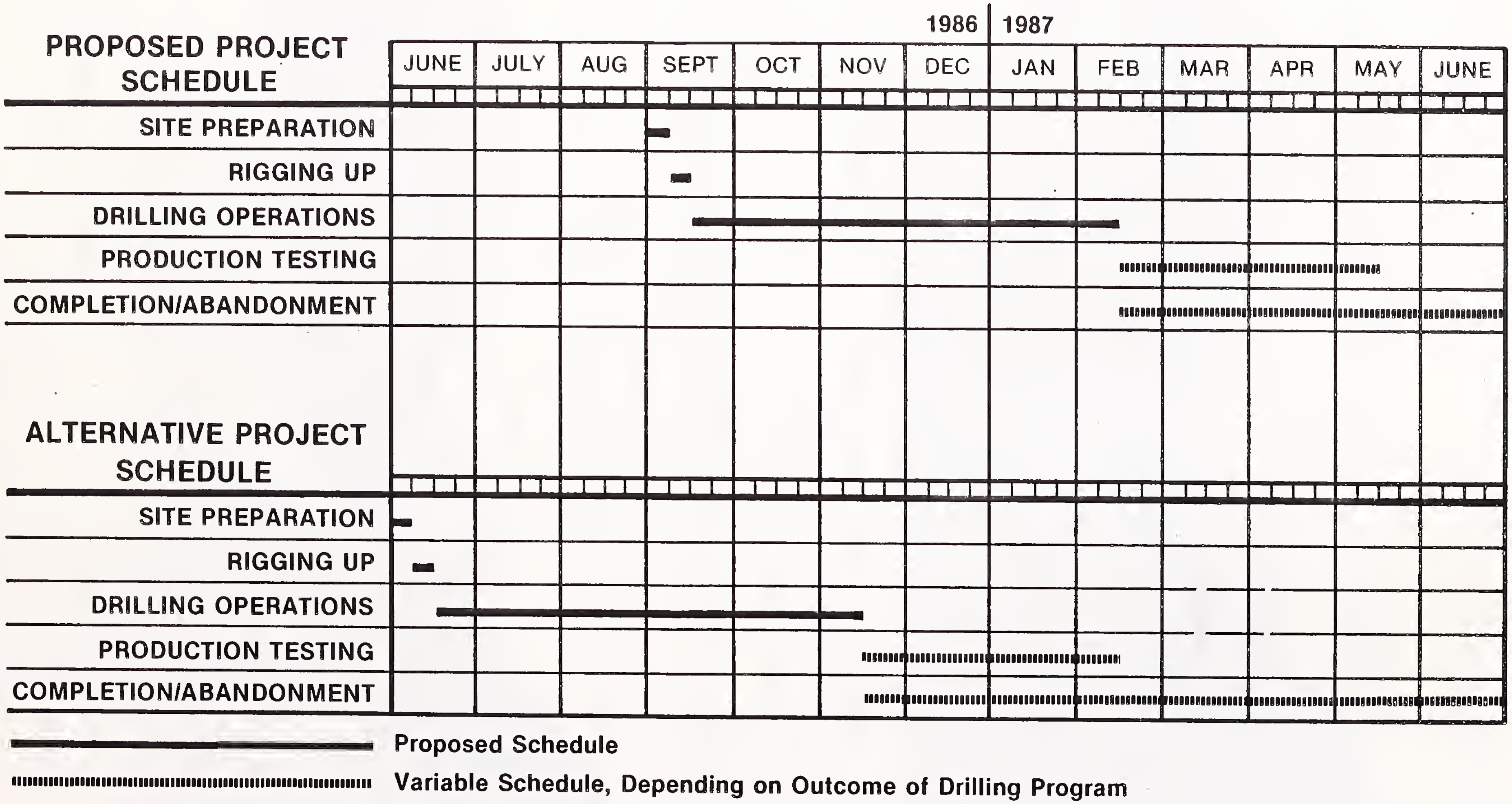


Figure 2-3 Proposed and Alternative Project Schedules

TABLE 2-2

ESTIMATED EMPLOYMENT AT THE PROPOSED BEARTOOTH EXPLORATION WELL

EMPLOYMENT CATEGORY	NUMBER OF PERSONNEL	EXPECTED PERIOD OF ON-SITE OCCURRENCE
Drilling Activities		
Drilling Foreman	2	Reside on-site
Toolpusher	2	Reside on-site
Mud Logger	2	Reside on-site
Morning Tour Rig Crew	5	Commute daily
Daylight Tour Rig Crew	5	Commute daily
Evening Tour Rig Crew	5	Commute daily
Mud Engineer	2	Commute daily
Drilling Engineer	2	Commute daily
Casing Crew	5	Commute 4 times during drilling
Cementing Crew	6	Commute 4 times during drilling
Salesmen, Service Companies	-	Irregular commute
Production Testing Activties		
Workover Foreman	2	Commute daily
Toolpusher	1	Commute daily
Rig Crew	4	Commute daily
Engineers	2	Commute daily
Stimulation Crew	6	Irregular commute
Salesmen, Service Companies	-	Irregular commute

working on-site. This number would increase to 15 to 17 employees for a one-hour period during shift changes. During casing and cementing operations, an additional 12 people would be on-site (maximum of 27 to 29). Casing and cementing would be required 4 times during the drilling program for periods ranging from 4 to 14 hours (depending on the length of casing to be installed and whether a production string is set).

Production Testing

Amoco would conduct preliminary evaluations of the hydrocarbon potential of the exploratory well during the drilling program. If warranted based on the preliminary evaluations, Amoco would proceed with a more extensive program to test and evaluate the commercial potential of the hydrocarbon reserves encountered. The need, and specific procedures to be employed during production testing, cannot be evaluated until the drilling program is completed. Amoco estimates that, if needed, production testing could require one to three months to complete.

If a production testing program is justified, Amoco would dismantle the large drilling rig and erect a smaller service rig on the well site. Equipment would be installed to separate and store produced liquids and to flare produced gas, as shown on Figure 2-4.

Production testing would involve a variety of procedures to estimate the potential volume and flow rate from formations identified during the drilling program as potentially productive. A string of small diameter pipe, or tubing, would be inserted into the cased well through the lower-most potentially productive zone. A series of control valves, or a "Christmas tree", would be installed on the surface. Production testing would be accomplished by inserting equipment into the well to perforate the well casing in the lower-most potentially productive zone, allowing gas, oil, or water to flow into the well bore and to the surface through the tubing. The well would be allowed to flow (with liquids collected, measured and contained and gas measured and flared) for a defined period of time to estimate the potential rate of production from the well. Depending on the results of the flow test, the formation may be further tested to

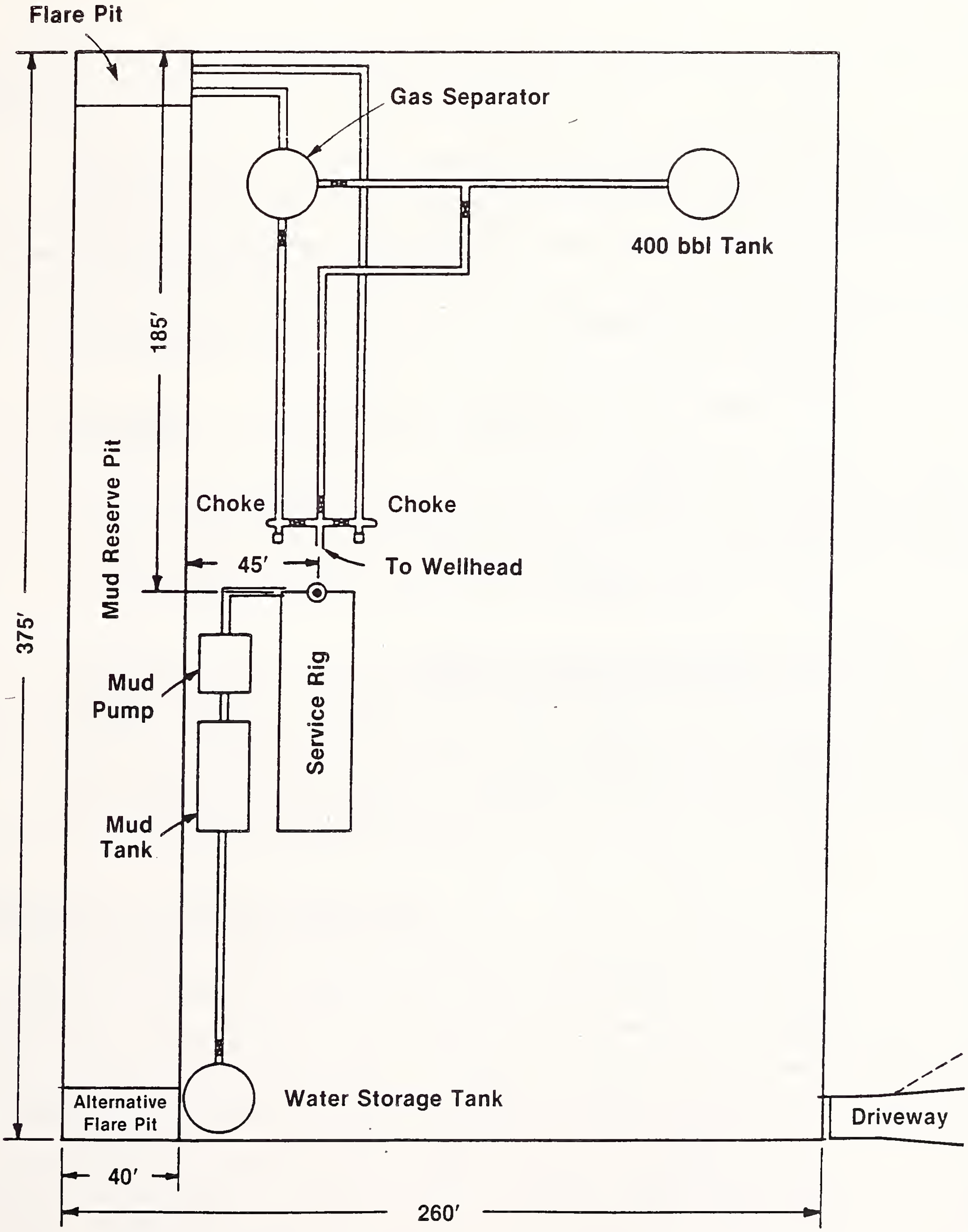


Figure 2-4 Typical Production Testing Layout

Not to scale

determine if hydrocarbon flow may be augmented by increasing the permeability of the geologic formation through acidizing, fracturing, or other stimulation techniques.

The testing procedures would be completed on each potentially productive zone, moving from the bottom up to determine the commercial value of the well. Depending on the outcome of the tests, the well could then be plugged and abandoned, or production equipment installed to allow future removal of the hydrocarbon reserves.

During routine testing operations 6 to 7 people would be working on-site; this number would increase to up to 15 people when stimulation operations are under way (Table 2-2). Production testing activities would be conducted only during daylight hours. All production testing personnel would probably commute daily from Powell, Wyoming.

Site Restoration and Abandonment

Plans for restoration and abandonment of the proposed well site depend both on the results of the drilling and production testing programs and on the desires of the landowner. If the well is determined to be commercially productive, the site would not be restored following the production testing phase. The mud reserve pit and other portions of the wellpad not needed for production would be stabilized and revegetated. The wellhead would be left in place inside a fenced, secure area. Amoco would evaluate the additional wells and facilities needed to proceed with development and prepare a conceptual development plan for the area. The conceptual development plan would be submitted to the BLM and other authorizing agencies for additional environmental review, as described in Appendix A.

If commercially productive hydrocarbon reserves are not discovered, the exploration well would be plugged and the site would be restored according to agreements with the private landowner. The terms of the agreement with the landowner stipulate that Amoco would reclaim the site in a manner consistent with the requirements of the Montana Board of Oil and Gas Conservation; the landowner retains the right to designate if the water well, access driveway, wellpad, or other facilities are to be left in place for his future use. Options for the treatment of individual facilities are as follows:

- Exploration Well. If commercial quantities of oil and gas are discovered, the well would not be abandoned, as noted above. If the well is dry or not commercially viable, it would be abandoned. The well would be plugged with cement and capped. All surface equipment would be removed.

- Water Well. The water well would be left in place and registered to the landowner.

- Driveway. The driveway would be left in place according to the agreement with the private landowner.

- Mud Reserve Pit. The mud reserve pit would be reclaimed. Amoco would obtain the necessary permits to remove pit fluids and haul them to reserve pits of recently drilled wells in the Elk Basin field of northern Wyoming. The reserve pit would be filled and recontoured to blend with adjacent topography.

- Wellpad. All surface facilities would be removed. Depending on the landowner's wishes, the wellpad may be left as is for his future use, or it may be reclaimed and revegetated. If reclamation is requested, Amoco would grade the pad to reestablish original surface contours. Topsoil salvaged during construction would be reapplied and treated to establish a seed bed for revegetation. The area would then be reseeded, according to landowner desires, to establish vegetative cover.

Resource Protection Considerations

The proposed Beartooth Exploration Well would be subject to a variety of general and specific requirements for environmental protection. General requirements applicable to the project include Federal Oil and Gas Regulations (43 CFR Part 3160), Onshore Oil and Gas Order #1, various BLM Notices to Lessees, the BLM's Surface Operating Standards for Oil and Gas Exploration and Development, and the Montana Department of Natural Resources and Conservation's General Rules and Regulations relating to oil and gas. Amoco's proposed project was developed to conform to the requirements of these regulations and standards.

Specific requirements and commitments for resource protection were developed during preparation of this EA, or were contained in stipulations to Federal Minerals Lease M-38867, Amoco's agreement with the private landowner, and Amoco's proposed Drilling Plan and Surface Management Plan. Specific commitments considered part of Amoco's Proposed Action are as follows:

- Surface Occupancy Restrictions. Amoco's proposal to explore Federal Lease M-38867 by directionally drilling from nearby private land stems from No Surface Occupancy stipulations in the federal lease. These stipulations prevent construction of roads or wellpads on the federal land due to terrain limitations and use of the area by wintering big game.

- Adjacent Area Protection. All surface disturbing activities would be restricted to designated areas as specified in Amoco's Surface Management Plan and approved by BLM.

- Cultural Resource Protection. The federal minerals lease stipulations required completion of a cultural resource inventory of the wellsite and adjacent leased federal lands. The inventory was completed and is on file in the BLM Miles City District Office. Amoco is required to notify the BLM if historic, archaeological, or paleontological resources are encountered during the construction of the wellpad.

- Noise. Amoco proposes to use a diesel-electric drilling rig that minimizes noise production. To further reduce noise levels, Amoco would install additional muffler equipment on the generator exhaust stacks.

- Visual Resource Protection. The federal minerals lease stipulations require consideration of scenic and aesthetic values. Permanent facilities must be designed or treated to blend into the surrounding area according to visual resource management guidelines of the Custer National Forest.

- Water Quality. A septic system would be installed for treatment of sewage from portable toilets and trailers on-site. Drilling muds and produced liquids would be contained in the lined mud reserve pit during drilling and hauled from the site for permanent disposal at an approved location in the Elk Basin Field in northern Wyoming. The mud reserve pit would be lined with bentonite and an impermeable synthetic membrane to prevent seepage. Trenches would be constructed around the drill rig to intercept rig washings and other fluids and transport them to the reserve pit.

- Sediment Control. Amoco would install sediment traps in the drainage ditch adjacent to Highway 212 to limit or prevent increases in the sediment load in Rock Creek.

* Waste Disposal. Trash and other waste materials would be contained in receptacles on-site and hauled to an approved landfill for disposal.

* Livestock Grazing. The existing gate at the Highway 212 turnout would be replaced by a cattle guard.

* Wildlife. Except for essential personnel required to be on-site at all times during drilling, personnel would not reside on-site. No camping or hunting would be allowed on-site. No firearms would be allowed on-site.

* Soils. To aid revegetation of the site, Amoco would salvage approximately 10 inches of topsoil from the level and gently sloping portions of the well site (Charlos soil series). The topsoil would be stockpiled on-site.

* Reclamation. Reclamation and revegetation of the wellpad would be completed according to the wishes of the private landowner. Unless the landowner specifies otherwise, the site would be reclaimed and revegetated upon abandonment.

Health and Safety Considerations

Amoco would implement a variety of practices to ensure the health and safety of company employees, contractors, and the public. The drilling operation would conform to the general requirements of the federal Occupational Safety and Health Administration (OSHA) and the company's Safety Handbook. Public access to the site would be discouraged by posted warning signs and restricted access to the wellpad.

The proposed Beartooth Exploration Well would penetrate geologic formations which have produced hydrogen sulfide (H_2S) gas in other locations. While H_2S may not be encountered in the Beartooth Well, its potential occurrence requires prior planning to assure safe operations, if the gas should be present. H_2S gas has three properties which must be considered in the design of a drilling program: (1) H_2S is highly flammable, (2) H_2S is a toxic gas and may be dangerous to humans at high concentrations, and (3) H_2S is highly corrosive. Although the potential presence of

H_2S requires careful planning of drilling and production testing activities, the oil and gas industry frequently drills in H_2S environments.

Both agency (BLM) and industry (American Petroleum Institute) guidelines have been developed to guide drilling operations when there is a potential to encounter H_2S. As required by BLM regulations, Amoco has developed a draft H_2S Contingency Plan (Envirosafe Inc. 1986) which applies BLM, API and Amoco standards to the proposed Beartooth Exploration Well. The general features of the plan are summarized in Table 2-3. BLM must review and approve the contingency plan as a separate action prior to acting on the APD.

ALTERNATIVES TO THE PROPOSED ACTION

Two alternatives to the proposed action are evaluated in this EA: (1) an alternative drilling schedule, and (2) the No Action Alternative.

Amoco has proposed a fall-winter (September to February) drilling schedule (Figure 2-3). An alternative spring-summer (June to October) drilling schedule is evaluated to identify the potential consequences of changes in the drilling schedule. Because this is an initial exploratory well, drilling could require more time than Amoco estimates. The alternative drilling schedule was included in the EA to provide additional consideration of the seasonal aspects of potential environmental impacts or concerns.

The federal action considered in the EA is BLM's approval of Amoco's APD. The No Action Alternative considers the ramifications of BLM's denial of Amoco's APD. Although the No Action Alternative must be considered under NEPA, BLM's authority to implement the No Action alternative is limited. Oil and gas leases grant the "right and privilege to drill for, mine, extract, remove, and dispose of all the oil and gas deposits" in the lease area, subject to the stipulations of the specific lease agreement. Thus, BLM retains the right to deny the APD only if the proposal would violate lease stipulations or applicable laws and regulations. This action would not deny Amoco's right to modify its proposal and resubmit an APD to drill in the same location. Complete denial of activity on Federal

Minerals Lease M-38867 would require action by Congress to authorize exchange, condemnation, or buy-back of the lease (BLM 1985).

TABLE 2-3
SUMMARY OF H_2S DRILLING PROCEDURES AND CONTINGENCY PLANS

* **Formal Contingency Plan**

* **Safety and Emergency Response Training**
  - Full H_2S safety training and education for all essential drilling personnel
  - Periodic safety drills
  - First-aid training for all employees

* **Safety Equipment**
  - Fixed and portable breathing equipment
  - Automatic H_2S detectors
  - Alarms and warning lights
  - Portable H_2S detectors
  - Explosion meters

* **Drilling Operations**
  - Use approved casing strings of rated strengths to meet minimum safety requirements
  - Maintain correct chemical properties and weight of drilling mud
  - Install hydraulic blowout preventers during drilling operations
  - Periodic inspection and testing of blowout preventers

* **Emergency Plan**
  - Assignment of responsibility, authority, and lines of communication for drilling site and emergency preparedness personnel
  - Evacuation plan for drilling site personnel and nearby residents
  - Wind socks
  - Designated safety briefing areas
  - Designated emergency routes
  - Plan to alert general public within 2.5 mile radius contingency area
  - Plan to alert public safety personnel
  - Lists of emergency phone numbers
  - Warning signs at public and access roads accessible to exposure area
  - Plans to block public and access roads
  - Plan to evacuate unauthorized personnel
  - Well ignition protocol
  - Radio and telephone communications

CHAPTER THREE

AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter of the EA describes the environmental resources affected by the proposed Beartooth Exploration Well and the potential effects of proposed activities on those resources. The majority of the chapter is organized by resource topic (e.g., Soils, Vegetation, etc.), with discussions of the **Affected Environment** and **Environmental Consequences** included under each resource heading. These sections address the probable environmental consequences of project development as outlined in Chapter Two.

The last section of the chapter, **Health and Safety Risk Assessment**, addresses the possibility of unanticipated, emergency conditions associated with the proposed exploration well. Specifically, the Health and Safety Risk Assessment examines the possibility of accidental releases from the well and describes the potential health and other environmental risks associated with such an event.

The information presented in this chapter is based primarily on existing environmental information for the well site and surrounding area available from the USFS, Montana Department of Fish, Wildlife and Parks, and other agencies. Impact analyses were completed by Dames & Moore's interdisciplinary team. **Appendix B** describes the specific methodologies used to develop the information presented in this chapter.

CLIMATE AND AIR QUALITY

Affected Environment

The Red Lodge, Montana vicinity has a modified continental climate. The unique climatology of the area is determined by its location on the northeast slope of the Rockies. The terrain rises sharply west and southwest of Red Lodge, while to the east is the relatively flat and broad Rock Creek Valley floor. The short summers are characterized by moderate daytime temperatures, cool nights and low humidity. Winters are long and cold, but extreme conditions are rare.

The mean annual temperature is 42°F, with a normal diurnal variation of 24°F. In July, the mean monthly temperature is 64°F with an average daily maximum of 79°F and minimum of 50°F (U.S. Department of Commerce, undated). During winter, temperatures fall to 0°F or below an average of 19 days per year. In January, the mean monthly temperature is 22°F with an average daily maximum of 33°F and minimum of 11°F (U.S. Department of Commerce, undated).

Total precipitation in the Red Lodge vicinity averages 23.2 inches with over 50 percent of the moisture falling from March through June. December through February is generally the driest period of the year. Snowfall can occur from September through June. Average yearly snowfall is 124 inches with the greatest accumulations, greater than 23 inches, in March and April (U.S. Department of Commerce, undated).

Wind direction and wind speed data are not available for the Red Lodge area. For analysis purposes, conditions for the Rock Creek Valley were approximated using data available from the Stillwater River Valley which is similar in orientation to the Rock Creek Valley and located about 35 miles to the northwest (Anaconda 1981). Based on the Stillwater River Valley data, wind direction is predominantly from the southwest (down-valley) during evening, night, and morning hours. During the day, both down-valley (southwest) and up-valley (north-northeast) winds occur with similar frequency. The dominant wind speed class for down-valley winds is 12-17 miles/hours (5.5-7.8 meters/second) and 4-8 miles/hour (1.7-3.4 meters/second) for up-valley winds. USFS personnel indicated that, based on their observations, wind velocities are generally greater in the Stillwater River Valley than in the Rock Creek Valley.

Air quality data are not available for the well site. Based on regional air quality data which included the Red Lodge area (USDA 1977), air pollution is considered to be minimal in the region. These data indicated mean concentrations of total suspended particulates of 24 ug/m^3, slightly higher than the estimated average for rural areas in the Rocky Mountain region. Mean concentrations of SO_2 and NO_2 were 7.6 ug/m^3 and 12.5 ug/m^3, respectively. These values are near the lower limits of detection for these compounds and much less than state and federal ambient air quality standards. Present sources of air pollution for the region include automobile engine exhaust, wood smoke from fireplaces, wildfires, and fugitive dust from roads and agricultural areas.

Environmental Consequences

The proposed Beartooth Exploration Well would not affect local or regional climatic patterns. Proposed project activities would result in temporary pollutant emissions which would have minor adverse effects on air quality, as described below.

- **Fugitive dust** would result from earth moving activities during site preparation and site restoration. During drilling operations, dust may also occur when winds are strong. These emissions would be temporary and would not adversely affect long-term air quality.

- **Combustion emissions** would be produced during drilling and production testing by vehicles and the diesel generators used to power the drilling rig. Previous environmental analyses for similar drilling activities (USDI 1981) have demonstrated that combustion emissions from these sources would be minimal and temporary.

- **Sulfur dioxide**, carbon dioxide and other combustion emissions would also result if natural gas is produced during production testing activities. Gas produced during testing activities would be flared for safety reasons. In flaring the well, hydrogen sulfide (H_2S) bearing gas, if present, would be ignited to produce a buoyant plume of sulfur dioxide. Periods of flaring would usually be limited in duration to between 6 and 24 hours; thus, sulfur dioxide emissions would be limited and temporary.

None of the projected emissions would have significant or long-term effects on air quality. A well blowout, or other uncontrolled gas release from the well, could result in additional air quality impacts, as described in the **Health and Safety Risk Assessment**.

NOISE

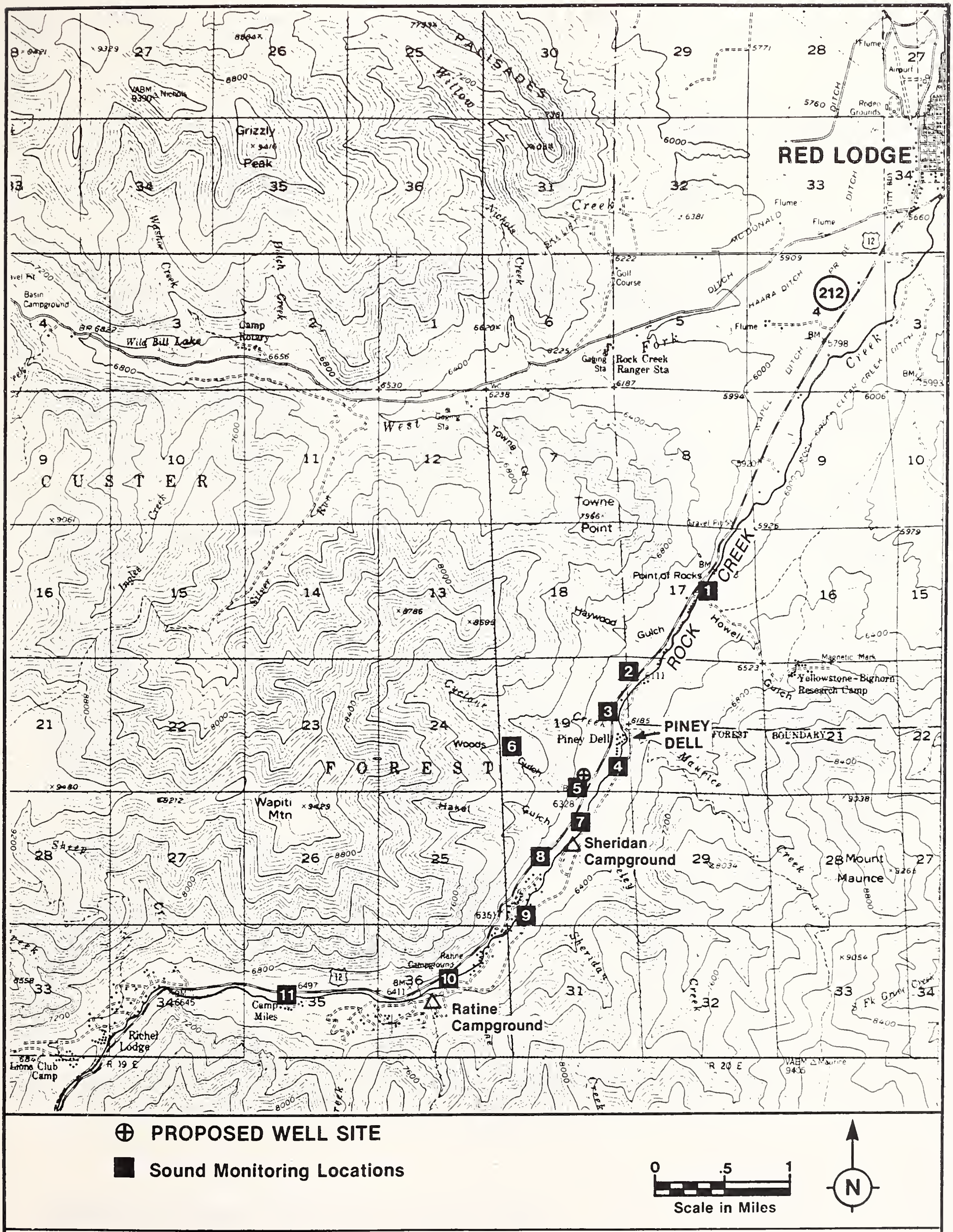
Affected Environment

Amoco's proposed well site is located on an undeveloped tract of land adjacent to Montana Highway 212, approximately 600 feet west of Rock Creek. The existing sound environment is characterized by natural sounds (e.g., water flow in Rock Creek, wind, etc.), modified by sounds from vehicles passing on Highway 212 and human activities in recreational areas in the project vicinity. Noise sensitive receptors in the vicinity of the proposed well site include: the Grizzly Condominiums and other developments at Piney Dell; the USFS' Sheridan and Ratine Campgrounds; elk and deer winter range in the vicinity of the well site; and private residences along Rock Creek.

Existing sound levels near the well site were measured by Dames & Moore during November 1985. Data were analyzed to estimate average day/night sound levels (using the A-weighted decibel scale) at twelve monitoring locations in the Rock Creek Valley near the proposed site (Map 3-1). Estimated day/night ambient sound levels, summarized in Table 3-1, ranged from a low of 25 dBA for measurements performed in Woods Gulch, west of the proposed site, to a high of 65.5 dBA for measurements performed in the Sheridan Campground, adjacent to Rock Creek. Comparison of these ambient sound levels with other familiar sounds (Figure 3-1) suggests a quiet environment throughout the Rock Creek Valley. Sound levels are higher close to Rock Creek and are anticipated to increase during the early summer periods when Rock Creek is at high flow.

Environmental Consequences

The proposed Beartooth Exploration Well would increase noise levels near the well site due to vehicular traffic, equipment operation, and drilling activities. Noise sources and intensity would vary during the project, depending on the types of activities being completed. During site preparation activities, and again at project abandonment, large earth moving equipment would be used to grade the site. During rigging-up operations, noise would be generated by equipment operation and the movement of



Map 3-1 Location of Sound Measurement Sites

TABLE 3-1
SUMMARY OF AMBIENT DAY/NIGHT AVERAGE NOISE ESTIMATES (in dBA) NEAR THE PROPOSED BEARTOOTH EXPLORATION WELL

MEASUREMENT STATION[1]	DAY/NIGHT NOISE ESTIMATE[2]
1	21.0
2	46.5
3	44.5
4	43.5
5	33.0
6	25.0
7	65.5
8	49.0
9	32.0
10	42.5
11	45.5

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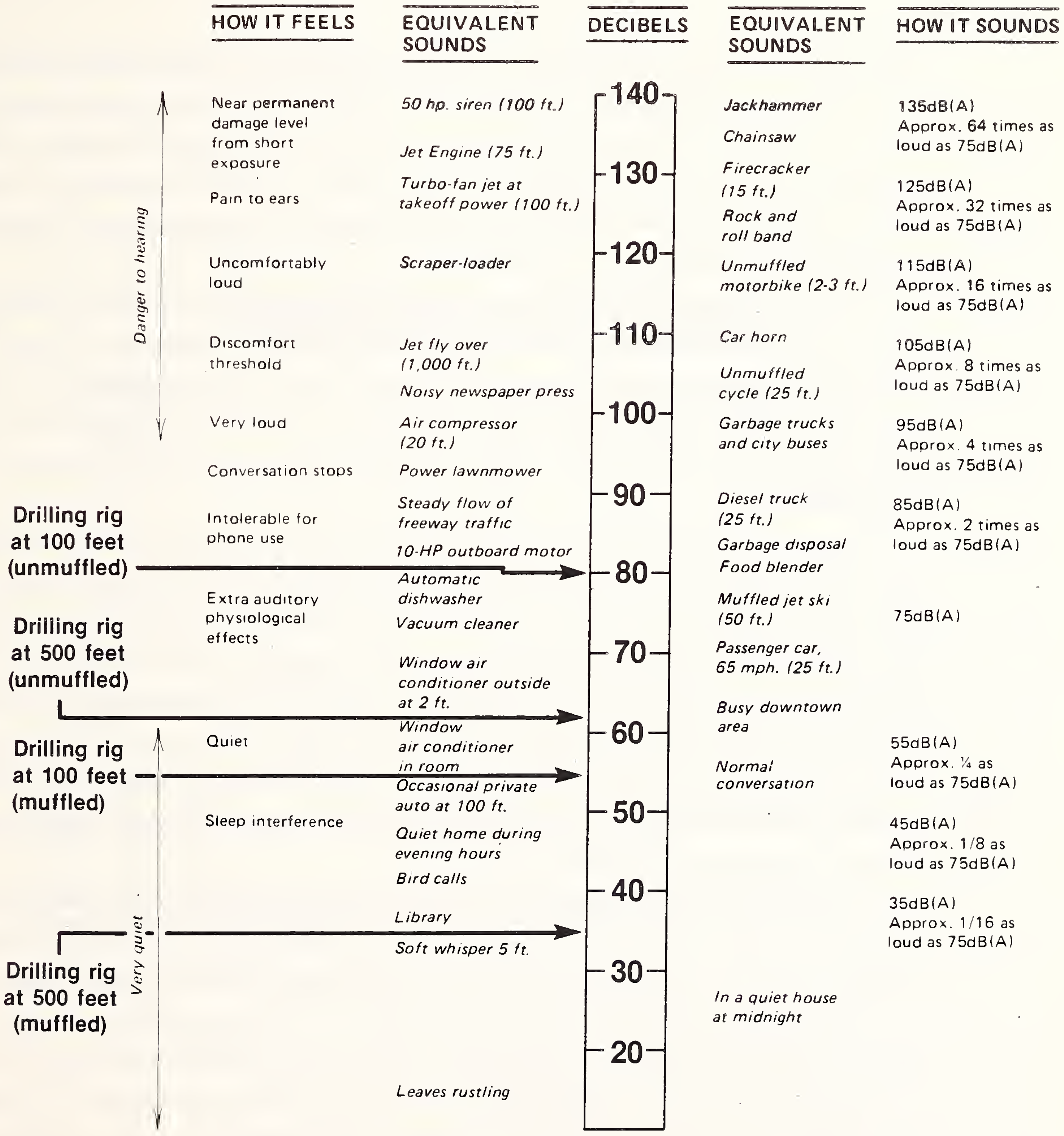
[1] Refer to Map 3-1 for locations.
[2] Based on ambient measurements completed during November 1985.

See Figure 3-1 for comparison of noise levels



Decibel levels of sounds you're most likely to encounter in A-scale numbers.

Figure 3-1 Noise Level Comparison Chart

Note: Modified from the Federal Energy Regulatory Commission, and BLM and U.S. Forest Service (1985) large trucks used to transport the rig components. These operations would each last approximately one week and would occur only during daylight hours. Although it is not possible to quantify in advance the noise levels associated with site construction, rigging-up, or site restoration activities, project related noise would be expected to constitute a temporary annoyance, at worst.

Noise generation during drilling and production testing operations would be associated with vehicle movements and the operation of drilling equipment. Significant increases in noise levels due to vehicle traffic would not be expected because passenger vehicle traffic increases would be minor and only occasional large truck traffic would be required (see **Transportation**).

Noise levels associated with operating the drilling rig were identified as an important concern to local residents since the drilling rig would be operated 24 hours per day until the well reaches total depth. Amoco proposes to use a diesel-electric powered drilling rig on the Beartooth Exploration Well. This type of drilling rig produces a relatively constant noise level which is less noticeable than the variable noise levels produced by other types of rigs. Amoco has also proposed to further minimize noise levels by equipping the rig with special mufflers designed for use in sensitive areas.

To gain an understanding of the noise levels that would be anticipated during the drilling period, Dames & Moore completed a noise measurement program near an operating drilling rig similar to the rig Amoco would use on the proposed Beartooth Exploration Well. The measurement program was conducted during November 1985 at the site of the Manning 34-E drilling rig which was drilling an exploration well for Texaco near Cody, Wyoming. Conditions at the Texaco well site were sufficiently similar to those at the proposed Amoco site to allow estimates of noise levels during drilling (Table 3-2). The Texaco rig was not equipped with mufflers; thus, manufacturer's specifications (Amoco 1986) were used to estimate the noise level reductions that would result from the special muffler equipment proposed by Amoco.

TABLE 3-2

ESTIMATED AVERAGE DAY/NIGHT SOUND LEVELS ASSOCIATED WITH DRILLING RIG OPERATIONS

DISTANCE FROM RIG (ft.)	ESTIMATED SOUND LEVELS (dBA)	
	Without Mufflers[1]	With Mufflers[2]
100	± 80	± 55
250	± 65	± 40
500	± 60	± 35
1,000	± 58	± 33
2,000	± 55	± 30

---

[1] Based on measurements taken in November 1985 at the Manning 34-E rig near Cody, Wyoming.

[2] Based on an estimated reduction of 25 dBA provided by equipment manufacturer (Amoco 1986).

See Figure 3-1 for comparisons of noise levels.

Environmental Protection Agency guidelines recommend 50-55 dBA as a general threshold of acceptable sound levels for all environments. Although site conditions (e.g., wind, terrain, other noise sources) would affect the actual sound levels experienced during the drilling, it is estimated that drilling-related sound levels would meet this general threshold within 100 feet of the rig and would attenuate to low levels away from the wellpad (Table 3-2). Existing sound levels near the proposed drilling site exceed the 50-55 dBA threshold in areas adjacent to highway 212 (due to vehicle movements) and Rock Creek.

Based on the measurements taken near the Manning 34-E drilling rig, Amoco's proposed project (with mufflers installed) would produce low-level background noise. As discussed in the section on **Wildlife**, elk and deer would probably habituate to the low-level background noise and would not be significantly affected. At the nearest human use areas (Piney Dell, Sheridan Campground, and summer home sites), the sounds may be distinguishable from other noises in the environment. As discussed in the **Recreation** section, the sound of the drilling rig may temporarily decrease the quality of the recreation experience for some people, depending on individual's responses to the additional noise source. Under the Proposed Action, comparatively few people would be affected because drilling would be completed after the peak recreation season. Summer drilling under the Alternative Drilling Schedule would coincide with the peak tourist season and would affect a larger number of people.

TOPOGRAPHY

Affected Environment

Amoco's proposed well site would be located on the western edge of the Rock Creek Valley at elevations between 6,240 and 6,265 ft. above sea level. Much of the site is relatively flat with slopes of 2-8 percent. Slopes increase sharply to 42 percent on the western portion of the site where the mud reserve pit would be excavated.

Environmental Consequences

Prior to erecting the drilling rig and other equipment on the well site, Amoco would grade the site to establish a level pad at an elevation of 6,246 ft. above sea level. Standard cut-and-fill construction techniques would be employed, with cuts of up to 25 ft. and fill of up to 5 ft. required to level the site. Additionally, the mud reserve pit would be excavated to create a pit approximately 12 ft. deep on the western portion of the site. The proposed wellpad design balances cut-and-fill material to restrict construction disturbance and topographic alterations to a total of 2.75 acres at the well site.

The level working surface of the wellpad would be required throughout the drilling and production testing phases. Plans for restoration of the site depend both on the outcome of the drilling program and on the requirements of the surface landowner. If commercially viable oil and gas reserves are discovered, the level wellpad would be maintained for possible future installation of production equipment. The mud reserve pit would be backfilled and cut slopes would be permanently stabilized. If the well is not productive, the site would be restored as directed by the landowner. If requested by the landowner, the level wellpad may be left in place for his future use. Alternatively, the site may be regraded to reestablish original surface contours and revegetated.

GEOLOGY

Affected Environment

The proposed site is located in the extreme northeast section of the Beartooth Mountains. These mountains are an uplifted block of igneous and metamorphic rock characterized by high angle thrust faults. The rocks near the surface in the Beartooth Mountains are believed to have been uplifted about 70 million years ago and "thrust" up and over the younger Paleozoic sedimentary formations which underlie the site. These sedimentary formations (e.g., the Frontier, Muddy, Dakota, Phosphoria, Tensleep, and Madison) produce significant quantities of both oil and gas in the adjacent Bighorn Basin. The proposed well was specifically located to penetrate a potential hydrocarbon-bearing feature in the Missippian Madison formation. The target is the crest, or top, of a seismically defined anticlinal feature which is believed to be located in the immediate vicinity of the proposed bottom-hole location.

In more recent geologic time, the Beartooth Plateau was glaciated. Ice masses advanced northward down Rock Creek forming steep canyon walls upstream of the site. Material scoured from the plateau by the glacier was deposited downstream by the meltwaters of Rock Creek. In the site area, these outwash gravels were reworked into alluvial terraces which now fill the valley floor and make up the surficial material of the proposed site. Soils formed in the alluvium are characterized by high permeability and a high percentage of gravels, cobbles, and boulders; these characteristics impose some construction and engineering limitations (see **Soils** section).

The proposed site occurs at the southwestern corner of the Eastern Montana Seismic Region, a region that has experienced very little seismic activity (Qamar and Stickney 1983). West of the site is a very active seismic zone, the Intermountain Seismic Zone which extends from southern Nevada through Utah and Wyoming north to near Kalispell, Montana. Ground motion from seismic events in the Intermountain Seismic Zone may propagate to the site area, as occurred during the 1959 earthquake at Hebgen Lake in south-central Montana, at the western edge of Yellowstone National Park. The Hebgen Lake earthquake, the largest recorded in Montana, was determined to be Modified Mercalli Intensity X, because it resulted in landslides and other damage. A Modified Mercalli Intensity of VI was felt at the proposed site, approximately 100 miles east of the epicenter (Eppley and Cloud 1961). A Modified Mercalli Intensity of VI is qualitatively defined as follows:

> Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (BLM 1985).

The site lies in a Zone 2 seismic risk area, which means that moderate damage could result from seismic ground motion (Coffman and Von Hake 1973).

The nearest known active fault, the Lomar normal fault, lies approximately 50 miles southwest of the site at its closest approach (Witkind 1975). The last displacement known on this northwest-trending fault is in quaternary-age sediments (Pleistocene). Based on the present knowledge of the area, surface rupture at the site seems highly unlikely.

Environmental Consequences

The proposed drilling program would penetrate geologic formations to a depth of approximately 15,500 feet. The exploration and testing program would be used to better define the geology of the site vicinity, particularly the potential for hydrocarbon production from deep sedimentary formations. If hydrocarbon reservoirs are found, production testing would remove small volumes of oil or gas to better establish the commercial potential of the reservoirs.

A concern expressed during public scoping was that the proposed drilling program could potentially affect the geology and unique geothermal resources of Yellowstone National Park. The uplifted Precambrian rocks of the Beartooth Plateau form an uplifted wedge between the sedimentary rocks in which Amoco proposes to drill and the younger volcanic formations of Yellowstone National Park. The Precambrian rocks underlie all of the sedimentary units in the Red Lodge area, and apparently as well, all of the volcanic rocks in the Yellowstone area. Thus, there is no geologic or structural correlation or connection between the rocks to be penetrated by the Amoco well to the east of the Beartooth Plateau and the volcanic formations to the west of the Plateau. Consequently, the proposed exploration well would not affect Yellowstone National Park.

SOILS

Affected Environment

A soil survey was completed on the proposed well site using standard soil classification procedures (USDA-SCS 1975a). The site-specific survey was guided by and correlated with the Carbon County soil survey (USDA-SCS 1975b) which extended to within 0.5 mile of the site. Two soil series were identified on-site. The Charlos loam series occupies the gently sloping (2-8% slopes) alluvial terrace of the eastern portions (about 75%) of the site. The Maurice stony loam series occurs on the adjacent steep slopes (42%) which begin in the western portion (about 25%) of the site.

Samples of the horizons of each series were collected and analyzed for their basic agronomic properties by a certified soil testing laboratory. Based on the laboratory analyses, and the natural vegetative growth of the area, these soils have no adverse properties for native plant growth. The results of the laboratory analyses indicate that soil texture, pH, electrical conductivity (salinity), sodium absorption ratio, water holding capacity, and organic matter are all within the range of suitability for plant growth (Montana Department of State Lands 1977).

The Maurice soil is characterized as extremely stony, with coarse fragment content increasing from 35% in the surface horizon (0-5 in.) to 80% at depths of 22 to 40 in. The high percentage of coarse fragments in this soil limits its suitability for use as seedbed material for site revegetation. The steep slopes on which the soil occurs and high coarse fragment content indicate the Maurice soil would be unstable when disturbed. Additionally, the Maurice soil is highly permeable.

The Charlos loam soil has a high coarse fragment content in the subsurface horizons. Surface horizons (0 to 13 in.) exhibit comparatively low coarse fragment content (less than 3%). The coarse fragment content increases with depth, approaching 70% at depths of 26 to 32 in.

Environmental Consequences

Construction of the wellpad would directly disturb soils on 2.75 acres. Direct impacts would include: exposing soils to increased wind and water erosion through removal of vegetative cover; mixing of soil materials through excavating, grading, and leveling of the wellpad; and compacting soils through equipment operation and facility construction. These impacts would be short-term since they can be reversed with standard reclamation and revegetation practices. The actual duration of impact would depend on the landowner's decision regarding site restoration practices. Soils' impacts would be restricted to the well site and driveway and would not result in significant indirect effects off-site.

The physical characteristics of the soils present on the well site impose some limitations that should be considered during construction of the wellpad. Cut slopes in the Maurice soil would likely be unstable due to the steep slopes and extremely stony character of the soil. Water erosion from these slopes would be an important source of sediment which could adversely affect off-site water quality. However, the major cut slopes would drain onto (rather than away from) the wellpad and into the mud reserve pit, effectively containing the sediment (see **Surface Water**). Slope stability may be of concern to Amoco from a safety and operational standpoint and may require consideration in final engineering designs.

The permeability of on-site soil would also pose potential water quality concerns if drilling muds, fuels, or oil were discharged or spilled on the wellpad. Liquid effluents from the drilling operation would be discharged directly to the mud reserve pit; ditches or dikes would divert rig washing water and accidental spills to the reserve pit. The reserve pit would be lined with bentonite and an impermeable synthetic liner to prevent seepage.

Soil survey results indicated that the stony character of the Maurice soil profile and the lower horizons of the Charlos soil would limit their suitability for use as seedbed material for future revegetation of the site. The surface horizons (to approximately 13 in.) of the Charlos soil do not exhibit this physical limitation and are suitable for use as top dressing during revegetation. Based on these findings, Amoco would salvage the upper soil horizons (to a depth of approximately 10 inches) where the Charlos soil series would be disturbed by wellpad construction. The topsoil would be stockpiled at the south end of the well site for use in future revegetation.

GROUND WATER

Affected Environment

The alluvial deposits of the Rock Creek Valley provide a source of ground water for domestic supply for residences near the proposed well site. The nearest existing wells occur north of the site at the Piney Dell development and southwest of the site on the 400 Ranch. The alluvial aquifer is recharged by infiltration and stream flows in Rock Creek.

Hydrogeologic characteristics of the deeper geologic formations of the proposed wellsite are only generally known. However, all formations under the area can contain ground water with varying yields and quality.

Environmental Consequences

A new ground water well would be drilled near the well site to provide a water supply for the drilling operations. Water requirements would be approximately 0.0155 cubic feet per second (cfs) (an average of 10,000 gallons per day) or about 4.6 acre-feet during the entire drilling period. These withdrawals would not affect other ground water users near the drilling site since the radius of influence of the water well would extend only about 1,500 feet from the well and the drawdown at the well is estimated to be less than 9 inches. This estimate assumes no recharge; natural recharge and pumping-induced recharge from Rock Creek would both occur, so the actual drawdown would be smaller than this estimate.

Potential ground water contamination from the drilling program would be limited by design aspects of the mud reserve pit and the proposed well. The mud reserve pit would be lined with bentonite and an impermeable synthetic liner to prevent seepage. Drilling mud density would be maintained during drilling to prevent formation fluids from entering the wellbore and rising to the surface. Premium casing would be cemented in place in the well to isolate fluid-producing formations, prevent interformation mixing of water, and protect other underground resources.

SURFACE WATER

Affected Environment

The proposed wellsite is located in the Rock Creek Valley, approximately 600 feet west of the main course of Rock Creek. The wellsite is approximately 40 feet above the streambed elevation of Rock Creek, clearly outside of the floodplain and separated from the creek by Highway 212. The site lies in the watersheds of Cyclone Creek and Woods Gulch, tributaries which join Rock Creek from the west. Drainage from the site is intercepted by a ditch parallel to Highway 212 and flows to Rock Creek through a culvert opening approximately 500 feet north of the well site boundary.

Rock Creek is a northeast flowing perennial tributary of the Clarks Fork Yellowstone River. Rock Creek has a drainage area of approximately 124 square miles at the USGS gauging station at Red Lodge (Station 06209500). The average streamflow at this station is 175 cfs or 126,800 acre-ft. per year. The minimum and maximum recorded discharges are 14 and 3,110 cfs, respectively, and the maximum observed gauge elevation is 4.80 ft. Water quality data are unavailable for Rock Creek, except for some spot observations at its mouth near Silesia. In the vicinity of the well site, Rock Creek is an aesthetic stream with clear water.

Environmental Consequences

Minor reductions in stream flow in Rock Creek would occur during the drilling and production testing phases of the project due to ground water pumping and storage of surface runoff in the mud reserve pit. The water proposed to be withdrawn by the water supply well is 0.0155 cfs (an average of 10,000 gallons per day), or approximately 4.6 acre-feet during the entire project. Although ground water withdrawal would induce recharge from Rock Creek, the resulting decrease in stream flow would be insignificant since the total withdrawal rate is only 0.11 percent of the minimum recorded streamflow at Red Lodge. Surface water storage in the mud reserve pit would be similarly insignificant because the watershed intercepted by the pit would not exceed 50 acres, approximately 0.06 percent of the drainage area of Rock Creek at Red Lodge.

Amoco has incorporated several design features into its proposal to protect water quality in Rock Creek. Sediment traps would be installed in the drainage ditch below the well site to catch sediments eroded from disturbed areas before they reach Rock Creek. The mud reserve pit would be designed to contain drilling fluids and surface runoff from the wellpad. Seepage would be prevented by the bentonite and synthetic linings of the pit. Once drilling and production testing are completed, the reserve pit would be drained and the contents would be transprted to the Elk Basin Field in northern Wyoming for final disposal at an approved site. Amoco would obtain the appropriate permit from the State of Wyoming prior to transporting and disposing of the contents of the reserve pit.

AQUATIC RESOURCES

Affected Environment

The proposed well site is located approximately 600 feet west of Rock Creek. In the vicinity of the well site, Rock Creek is an aesthetic stream with clear water and a rock and cobble substrate. Although the stream appears to offer excellent fish habitat, it is not highly productive and possesses a limited fishery composed of brook trout and rainbow trout; past efforts to establish cutthroat trout have been unsuccessful (Fredenberg et al. 1985).

Throughout the upper section of Rock Creek (from its origin to Red Lodge) fisheries potential is limited by severe winter conditions and high flows during spring runoff which are not conducive to fish production. These conditions result from Rock Creek's comparatively high altitude; inherently low food production due to the stream's granitic base; and a steep gradient (averaging 128 feet per river mile) which provides little cover or shelter for large trout (Bishop 1967). Downstream from Red Lodge these conditions improve significantly and Rock Creek is highly productive, supporting excellent populations of brown, rainbow, and brook trout.

Despite the comparatively low productivity of the upper sections, all of Rock Creek is considered a valued fishery resource, ranking among the top five streams in the region (Fredenberg 1985). Between March 1984 and February 1985, Rock Creek supported 9,161 fisherman-days of recreation, 4,757 in the lower 20 miles of stream and 4,414 in the upper 40 miles which include the town of Red Lodge and the project vicinity. Although the fishery is not highly productive upstream from Red Lodge, Rock Creek is easily accessible from Forest Service lands and is highly visible from Highway 212, an important travel route for tourists and recreationists.

Environmental Consequences

The proposed exploration well would not directly affect Rock Creek. As discussed under **Surface Water**, water quality impacts are not expected due to design features included in Amoco's proposal. Only minor, temporary changes in flow would be expected as a result of the project. These would not affect the fishery in Rock Creek.

VEGETATION

Affected Environment

The vegetation of the proposed well site consists of big sagebrush steppe and grassland that corresponds to the *Artemesia tridentata*/*Agropyron spicatum* habitat type of Mueggler and Stewart (1980). Grazing pressure appears to have altered the community composition to include numerous invader and increaser plant species. Although big sagebrush remains a principal component of the vegetation, cheatgrass brome, knapweed, shepherdspurse and smooth brome are abundant. Other common species are bluegrass, timothy, western yarrow, wild buckwheat, spikemoss, prickly rose, cinquefoil and fringed sagebrush.

The proposed well site is adjacent to a steep east-facing slope that is characterized by scattered limber pine and thickets of common juniper. Other principal species include slender wheatgrass, bluegrass, pussytoes, wild buckwheat, creeping juniper, anemone, Idaho fescue, june grass and Douglas-fir saplings.

Rock Creek and its tributaries, Cyclone Creek and Woods Gulch, are characterized by a mixture of riparian tree and shrub species, including aspen, balsam poplar, redosier dogwood, willow, alder and currant. Subordinate, but common, species are cow parsnip, showy aster, snowberry, dogbane, creeping juniper, bluegrass, harebell and sedges. The stream banks often contain dense patches of bearberry, along with scattered common juniper, creeping juniper, Douglas-fir, and limber pine.

Environmental Consequences

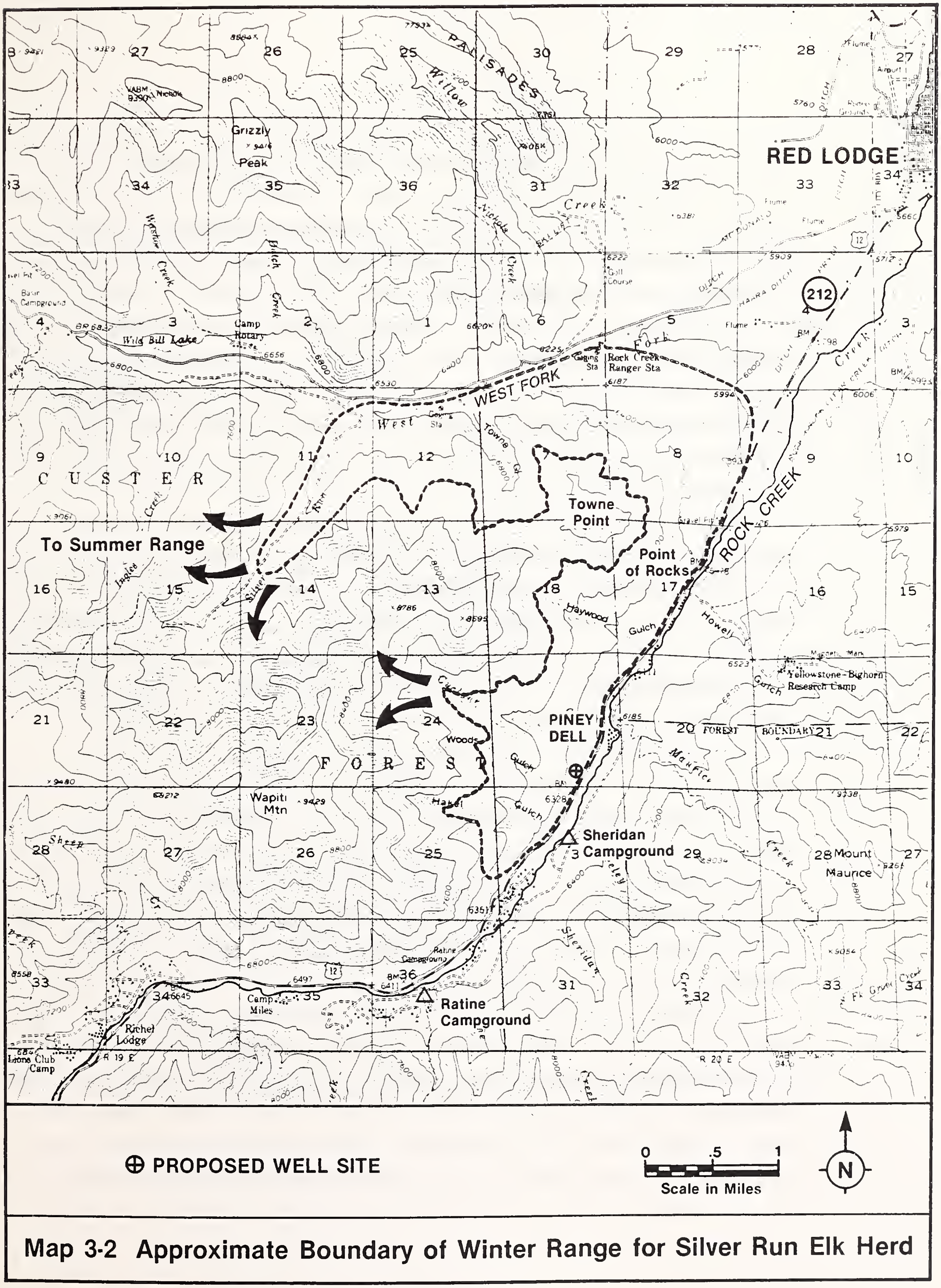
Construction of the proposed wellpad and highway turnout would require removal of all vegetation on approximately 2.75 acres of land. The site has good revegetation potential and would be revegetated when the site is abandoned, unless the private landowner requests otherwise. Topsoil would be salvaged and stockpiled for use in revegetating the site. The schedule for the restoration program would depend on the outcome of the drilling and production testing program; however, once seeding is completed, grass cover would be reestablished within 2 to 3 years. Natural invasion of shrubs and forbs would gradually result in a vegetative community similar to that of adjacent areas.

WILDLIFE

Affected Environment

The proposed well site occurs in an ecologically diverse region with extensive game and non-game wildlife resources. The USFS reported that more than 300 terrestrial vertebrates may occur in the Beartooth Range (USFS 1978a) and summarized general distribution patterns by vegetation community type (USFS 1978a, 1981b). Discussions with the Montana Department of Fish, Wildlife, and Parks indicated that elk and mule deer were of most concern (Stewart 1986) since the wellsite is located on a portion of the Rock Creek big game winter range. As noted in the **Recreation** section, hunting and wildlife viewing are important recreational pursuits in the area.

Records (Simmons et al. 1983a) indicate that elk or their sign have been observed in the vicinity of the well site from December through May. The general distribution patterns of the 140 animals in the Silver Run elk herd were reviewed by Stewart (1986). During the summer months, elk are absent from the vicinity of the drilling site and are utilizing summer range about seven miles west of the site (Map 3-2). With the advent of winter weather in the fall, the elk move down the West Fork of Rock Creek drainage reaching the lower West Fork and Towne Point in the main fork



Map 3-2 Approximate Boundary of Winter Range for Silver Run Elk Herd

drainage by December. Occasional elk may be in the vicinity of the drilling site at this time. As winter weather progresses and snow accumulates, the elk tend to move south one to two miles to the relatively snow free slopes in the Rock Creek Valley south of Towne Point. Most of the herd can be expected to be in the Rock Creek Valley by February 1. As the greenup of vegetation occurs, feeding becomes intense and the Rock Creek Range becomes critical to the herd. The March 1 to May 15 period is probably the most critical. This description of use applies to winters within the biometeorological normal. Winters more severe than normal will tend to force the elk onto the Rock Creek range earlier and to lengthen the critical period.

The main fork of Rock Creek is currently being impacted by the presence of Highway 212 and the homes and other occupied structures located along the highway. Suppression of elk and deer use typically occurs within 0.5 miles of traveled roads; thus, elk use of this area can be expected to be at least 25 percent below that which would be seen without the presence of the highway (Lyons et al. 1985). The proposed well site lies within this highway impact zone.

The location of the calving grounds of this elk herd has not been documented. The distribution of elk in May and June suggests that the calving area could extend from the vicinity of the well site into the West Fork of Rock Creek. The most probable area for calving is on the north side of Towne Point extending from the Waples Bench in section 8, west along the West Fork drainage (Stewart 1986). The presence of the highway in the vicinity of the drilling site suggests that it is not a likely calving area due to the lack of isolation.

The drilling site is located upon a major winter range used by several hundred mule deer. No censuses or detailed studies have been done for the area although management data have been collected (Simmons et. al. 1983a). Substantial use by mule deer is seen from December through May. The area south of Towne Point and the Point of Rocks becomes particularly important to the deer as the greenup of the range occurs in March. By March 15, the flats along the highway are usually free of snow. These flats may be used by 125 to 150 mule deer during March and April (Stewart 1986).

Environmental Consequences

The proposed exploration well would unavoidably disturb approximately 2.75 acres of elk and mule deer winter range. Given the size of the winter range and natural variations in environmental conditions (winter severity, forage production, etc.) the short-term direct loss of habitat would not significantly affect elk or mule deer populations. Depending on the outcome of the drilling program and landowner desires, the disturbed area may be reshaped and reseeded immediately following drilling and production testing. Revegetation would restore the disturbed area to productive winter range within a few years.

Wintering big game would also be exposed to potential indirect effects related to human activity and noise during periods when proposed activities overlap the December to May winter range use periods. As shown on Figure 2-3, the proposed project schedule would overlap the winter use period for 3 to 6 months, depending on the need for production testing. The alternative drilling schedule would conflict with the big game use period only if production testing is completed.

In either case, the indirect impacts associated with drilling and production testing are projected to have only minor effects on elk and deer distribution patterns and habitat use in the area surrounding the well site. The data of Goodwin (1975), combined with the results of studies just being completed (Picton et al. 1985), suggest that a conditional use zone may be defined around the wellpad. This conditional use area is defined as the area in which the drilling operations may influence big game use patterns, although the specific response would depend on all of the stimuli affecting the animals at any time. Based on the studies cited above and professional judgement, Picton (1986) estimated that the conditional use zone would be limited to the area immediately adjacent to Highway 212 (a strip about 100 yards wide), extending not more than 0.25 miles north and south of the wellpad. Drilling and production testing activities would not be expected to affect elk or deer outside of this 15 to 20 acre area.

The 15 to 20 acre conditional use zone lies within the existing highway impact zone where big game use is likely to be 25 percent below undisturbed range (Lyons et al. 1985). The drilling operations could incrementally reduce big game use, (perhaps 10 to 15 percent below current use levels), although the further reduction would be minor. The special mufflers proposed by Amoco would reduce drilling rig noise to ambient levels or below within approximately 500 feet of the wellpad. This type of constant, low-level background noise tends to be less disturbing than loud or variable noise. Similarly, regular patterns of human activity confined to a specific location are more easily accommodated than irregular or unpredictable activities. Since both noise levels and human activity patterns would be regular, predictable, and confined to the drilling site, it is likely that elk and deer would habituate to the drilling and/or production testing activities and continue to use the winter range surrounding the site. The conditional use zone would be used for feeding, primarily under the cover of darkness, although the total time spent in the zone could be reduced.

Under most circumstances, the minor reduction in big game use of the conditional use zone would not affect the health of individul elk and deer. During extreme weather conditions, such as an unusually prolonged winter followed by a cold, wet spring, small decreases in available forage may become more important to reproductive success. In this case, even small reductions in useable habitat may accentuate the adverse effects of the severe weather and decrease the calf and fawn crops. Weather records indicate this combination of weather conditions occurs with a maximum frequency of one year in ten. If this situation did occur, the condition of the herds would need to be reviewed and potential mitigation measures, such as supplemental feeding, evaluated with the Montana Department of Fish, Wildlife, and Parks.

In summary, the proposed drilling and production testing activities would not be expected to have significant impacts on wintering elk or mule deer. The proposed well would temporarily disturb 2.75 acres of winter range and contribute to minor reductions in habitat use on 15-20 acres. No long-term impacts on the well-being of the elk and mule deer herds are anticipated.

THREATENED AND ENDANGERED SPECIES

Affected Environment

The U.S. Fish and Wildlife Service was contacted during the scoping process for the EA to identify threatened and endangered species that may potentially occur near the proposed well site. Two species, bald eagle and peregrine falcon, were identified as species of potential concern. Site reconnaissance, further literature review, and discussions with nongame biologists with the Montana Department of Fish, Wildlife, and Parks lead to the conclusion that neither species is likely to be affected by the proposed exploration well.

The Yellowstone River and Clarks Fork Yellowstone River drainages are major winter concentration areas for the bald eagle, with up to 100 individuals documented in the two drainages (BLM 1983). Although wintering birds may occasionally occur in the Rock Creek drainage, bald eagles are not known to use the canyon area in the vicinity of the proposed drilling site. Bald eagles frequently feed on fish and waterfowl, and are usually associated with large streams and reservoirs where food is abundant. In the vicinity of the well site, Rock Creek does not provide habitat for wintering waterfowl or a highly productive fishery which would attract wintering eagles.

Skaar et al. (1985) note that bald eagles may once have nested in the general region; however, there are no recent records for the vicinity of the study area. The USFS (1985) reports no nests are currently known within the Custer National Forest. Flath (1986) indicated the nearest known nest is approximately 25 miles north of the site.

Peregrine falcons are considered an occasional migrant and rare nesting species in southern Montana. The USFS (1985) reports no recent peregrine sightings on the Custer National Forest. The well site is considered to be on the edge of an area which has suitable nesting habitat for the species, but for which there is no record of historic eyries (Flath 1985). Potential habitat in the immediate vicinity of the well site is limited by the extensive residential development along Rock Creek and the high recreational use during summer months.

Environmental Consequences

Neither the bald eagle nor the peregrine falcon is expected to occur on or near the proposed well site. Consequently, the proposed project would not affect threatened or endangered species.

CULTURAL RESOURCES

Affected Environment

Powers Elevation (1984, 1985) completed cultural resource surveys to comply with the stipulations of Federal Minerals Lease M-38867. During the inventory, available cultural resources information for the lease area and surrounding vicinity was obtained from file records of the Montana Historical Society and the BLM. In addition to the file search, an intensive pedestrian survey was completed for the well site and adjacent federal lands of the minerals lease area.

The file search disclosed no recorded cultural resources on or near the proposed site. No cultural resources were discovered on the well site during the intensive field inventory. Two historic sites and two historic loci were encountered on federal lands within 1 mile of the site. One site, Three Prospect Holes, is located about 1 mile west of the well site. A soldered can and miner's lamp encountered at the site date back to the 19th or early 20th century, suggesting the site is of some antiquity. The second site, Stone Fireplace Cabin, is located about 0.33 mile northwest of the well. This site consists of five prospect holes, prospect tailings, and a small frame cabin. The historic loci included an irrigation ditch and a single small prospect hole about 0.5 mile south of the well site. Powers Elevation concluded that none of the historic resources encountered were significant in terms of their eligibility for the National Register of Historic Places.

Environmental Consequences

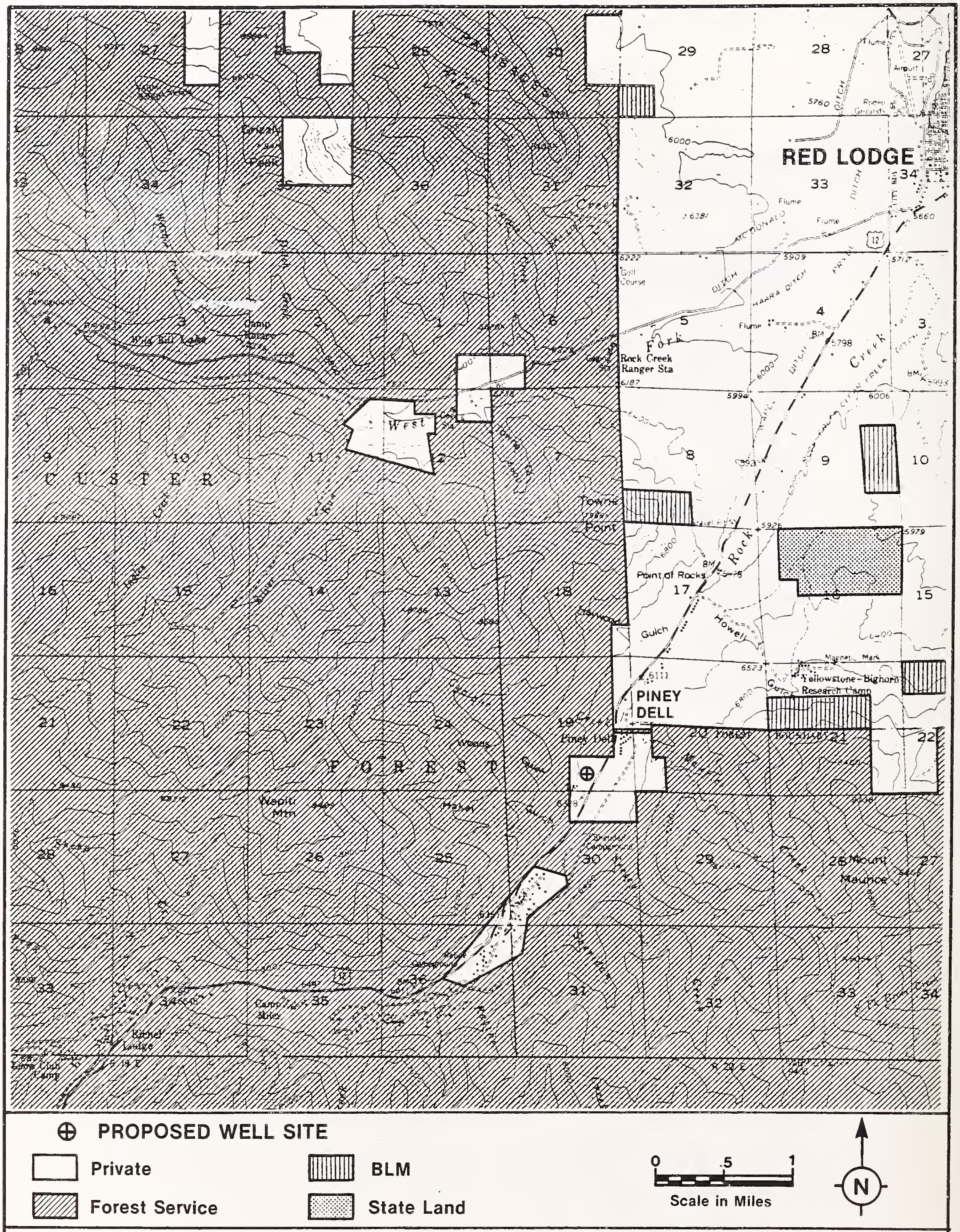
Based on the cultural resources inventory summarized above, no significant cultural resources exist on or near the proposed drilling site. Thus, cultural resource impacts are not expected to occur as a result of the proposed project.

LAND USE

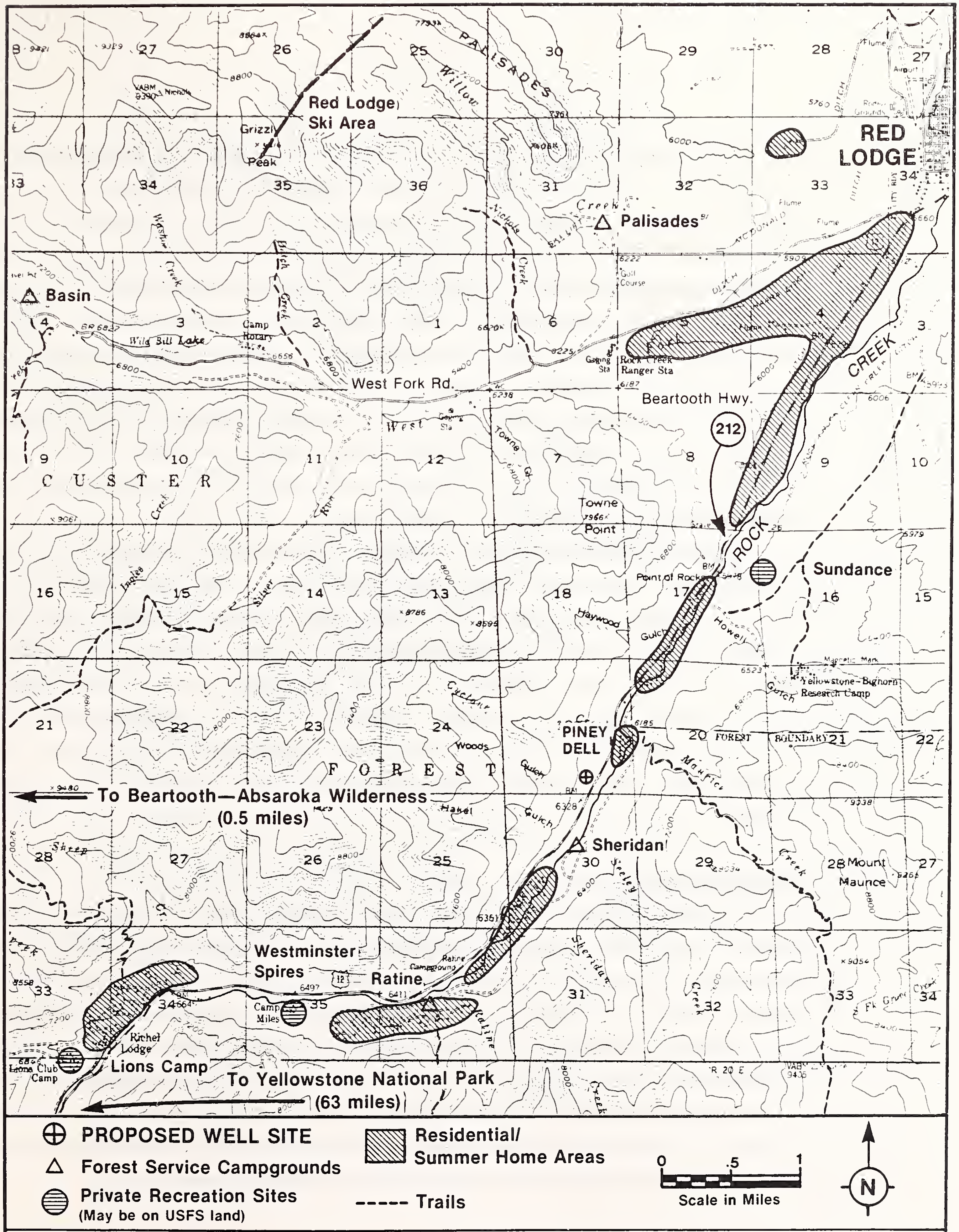
Affected Environment

The proposed well site is an undeveloped parcel of private land (Map 3-3) currently used for grazing. Surrounding land is primarily undeveloped rangeland and forest. Developed land uses are primarily recreation-oriented (Map 3-4), including USFS campgrounds and residential areas located adjacent to Rock Creek. Most of the residential development in the area consists of vacation homes/cabins which are primarily occupied during the summer.

An intensive Land Use inventory was conducted for lands within 2.5 miles of the proposed well site as part of Amoco's safety contingency planning effort (see **Health and Safety Risk Assessment**). Based on County records, 167 homes or cabins occur within 2.5 miles of the proposed well site. The developed land use closest to the site is the Rock Creek Mine Development at Piney Dell which includes the 15-unit Grizzly Condominiums, several cabins, and a restaurant and bar. The Piney Dell facilities are home to the Dynastar-Red Lodge International ski racing camp during June each year and provide dining and accommodations during the rest of the summer tourist season. Additional land uses within 2.5 miles include the USFS's Sheridan and Ratine campgrounds; the Sundance supper club and recreational facility (currently closed); and the Yellowstone-Bighorn Research Camp, a summer geology camp operated by the Yellowstone Bighorn Research Association.



Map 3-3 Land Ownership



Map 3-4 Recreational Facilities

Future land use patterns are likely to be similar to those currently in existence. The Carbon County Comprehensive Plan emphasizes efforts to maintain the agricultural and recreational themes within the county. Future developments would probably include additional residential and recreational development in the Rock Creek Valley, from the Custer National Forest boundary north to Red Lodge. There are currently no subdivision, rezoning, or site plan submittals pending in the vicinity of the well site.

USFS lands in the vicinity of the well site are administered by the Beartooth Ranger District of the Custer National Forest. FS management objectives for lands in the project vicinity are to maintain existing recreational opportunities and scenic values in the Rock Creek Valley (see **Recreation** and **Aesthetics** sections).

The USFS (1985) Land and Resource Management Plan for the Custer National Forest notes that much of the land within the Beartooth District has been leased for oil and gas exploration. Consequently, the USFS anticipates that oil and gas development activities, including drilling of exploration wells, may increase within the Beartooth Ranger District during the next decade. Leases within the immediate vicinity of the proposed well have been organized into the proposed Beartooth Federal Unit (see Map 1-2) to consolidate and coordinate the operating efforts of the several leaseholders.

Environmental Consequences

The proposed exploration well would directly affect approximately 2.75 acres of private rangeland, temporarily converting the land to an industrial land use. If a significant oil or gas discovery is made, a portion of this area could remain in industrial use for installation of production facilities. If commercial quantities of oil and gas are not discovered, the affected land would be restored to rangeland after drilling is completed, depending on the restoration specifications of the private landowner. Alternately, the landowner may choose not to reshape and revegetate the site and may use the wellpad for another purpose.

Existing land uses in the vicinity of the well site would not be significantly affected by the proposed well. As described in the section on **Noise**, the sounds of the drilling rig would be muffled with special equipment and would be at or below EPA guidelines within 100 ft. of the rig. The low background noise may be perceptible at Piney Dell and the Sheridan Campground. Similarly, as described under **Visual Resources**, the drilling rig would be visible from Piney Dell and from approximately ten houses to the north. These effects may be perceived as adverse; however, they would be temporary and would not preclude current land uses.

The proposed exploration well could affect future land use patterns, depending on the outcome of the drilling program. If commercial quantities of oil or gas are not discovered, further activities would probably not be proposed within the boundaries of the proposed Beartooth Federal Unit (Map 1-2). If an oil or gas discovery is made, development and production proposals may be forthcoming. As described in **Appendix A**, future proposals would be constrained by lease stipulations and existing land use controls.

RECREATION

Affected Environment

The mountains, valleys, lakes, and streams of the Beartooth Range south and west of Red Lodge provide outstanding outdoor recreation opportunities, including hunting, fishing, camping, picnicking, sightseeing, and winter sports. Recreation use is high due to the quality recreation experiences available year-round and the close proximity to Billings. Over half a million people visit Carbon County annually to enjoy the excellent recreation, including both national and local visitors.

Recreation forms an important part of the economy in Red Lodge and Carbon County. The Red Lodge Mountain Ski Resort, west of the city, is an important winter recreation site and a major local employer. The Custer National Forest is another important regional attraction with spectacular mountain scenery and extensive forest lands, streams, lakes, and rugged alpine areas providing diverse recreational opportunities in both primitive and developed settings. The Rock Creek Valley is the main access to the eastern edge of Absaroka-Beartooth Wilderness area.

The Beartooth Highway (Highway 212), which follows the Rock Creek Valley, is one of the most important travel routes to Yellowstone National Park, approximately 65 miles southwest of the proposed well site. Approximately 300,000 people (about 1,650 per day) travel on Highway 212 during the period between May and September when the highway is normally open. The highway provides significant sight-seeing opportunities and is considered a tourist attraction in its own right. A celebration of the 50th anniversary of the highway is planned for the summer of 1986.

Recreational opportunities in the vicinity of the proposed well site are summarized on Map 3-4. Public recreation facilities are primarily within the Custer National Forest where settings range from the primitive to the roaded-natural (USFS 1981a). Much of the primitive dispersed recreation in the area occurs in the Absaroka-Beartooth Wilderness, which extends to within 4.5 miles west of the well site. Trails leading from the Rock Creek and West Fork of Rock Creek valleys provide opportunities for hiking, camping, horse-back riding, cross-country skiing, and other activities in the wilderness area.

Opportunities for fishing, hunting, and wildlife viewing occur throughout the area. Rock Creek is a popular fishing stream. Hunting is prevalent throughout the region during October and November. The well site itself is not a hunting area due to its location adjacent to Highway 212, although areas west of the well site are popular during archery season. The close proximity of Highway 212 allows close observation of elk and deer during the winter periods when elk and deer are on winter range in the Rock Creek Valley.

Developed recreational facilities are also extensive. The USFS operates 7 campgrounds with a total of 86 camping units in the Rock Creek Valley. The Sheridan Campground (8 units) and the Ratine Campground (7 units) are located 0.5 and 1.5 miles, respectively, south of the well site. The USFS campgrounds are used primarily for relaxing, picnicking, hiking, and fishing by both overnight and day-use visitors. The USFS maintains several hiking and cross-country ski trails that depart the valley floor for higher elevations, including the Maurice Creek and Corral Creek trails near the proposed wellsite (Map 3-4).

Private recreation facilities in the Rock Creek Valley include two private camps, Lions Club Camp and Westminster Spires Church Camp; the Rock Creek Mine and Grizzly Condominiums complex at Piney Dell; and summer homes and cabins. The commercial development at Piney Dell is about 0.25 mile north of the wellsite. It serves as the base of operations for approximately 100 junior ski racers who attend a summer ski racing camp each June and provides overnight tourist accomodations during the remainder of the summer. Vacation homes and cabins are located adjacent to Rock Creek throughout the valley, with 167 within 2.5 miles of the well site.

Several types of recreational users occur in the Red Lodge vicinity: year-round residents; summer residents; week-end and holiday visitors from the surrounding region; and visitors from outside the region who are traveling through the study area. Approximately 75 to 80 percent of recreation visitors to the area come from nearby Stillwater, Yellowstone, and Carbon counties (Schaller 1985). Most of these people live within a 2-hour driving radius.

Most recreation use is in summer when families leave the heat of the plains to relax in the cooler mountain environment. Length-of-stay, and the weekly patterns of use, vary considerably with user type. Visitors from outside the region tend to stay overnight in the area during the week. Recreational use by people from nearby areas is greatest during the weekends, and nearly two-thirds is day-use only. Overnight visitors from within the region generally arrive Friday evening and spend the weekend. Peak use occurs on Memorial Day and weekends between late June and Labor Day. During this period, campgrounds in the Rock Creek Valley frequently experience over 90 percent occupancy.

Winter use is restricted by closure of the Beartooth Highway from October to June, but significant use occurs at the Red Lodge Mountain Ski Resort and on cross-country ski trails. Ski resort users are a mixture of day-users and overnight visitors. The greatest use in winter occurs on weekends.

Environmental Consequences

Potential impacts to recreational resources are identified by changes in recreational opportunities, recreational access, user volumes, or the quality of recreational experiences. The proposed Beartooth Exploration Well would not directly affect recreation sites or access routes, and thus would not affect recreational opportunities in the Rock Creek Valley. Significant changes in recreation use would not be expected since drilling crews and service company personnel would commute from their current bases of operation near Billings, Powell, or Cody.

The proposed exploration well would alter the setting in the Rock Creek Valley through the construction of the drilling rig and other equipment, additional background noise, and human activity. Temporary changes in the quality of recreational experiences may occur; however, the nature of the change in quality would depend on the reaction of recreational visitors to the drilling equipment and activity. It is likely that the industrial nature of the exploration well would be seen as inappropriate for its setting and reduce the quality of recreational experiences for some local residents and repeat visitors to the Red Lodge area. In contrast, the presence of the drilling equipment may enhance the recreational experience for first time or infrequent visitors who are unfamiliar with the area. Many tourists stop to photograph drilling rigs when they encounter them, due to their size and novel appearance. This may be expected near the proposed site and may contribute to temporary traffic slowdowns in the immediate vicinity of the well. This would be more evident during the summer season.

The relative potential for recreation impacts varies considerably depending on the drilling schedule. Amoco's proposed fall-winter drilling schedule would fall outside the busiest tourist season. The alternative spring-summer drilling schedule would coincide with the peak recreation season and would affect a much larger number of people.

VISUAL RESOURCES

Affected Environment

Dames & Moore completed a visual resources inventory for the well site and vicinity using analysis methods adapted from the USFS (1974) Visual Management System and the BLM (1984) Visual Resource Management System. The visual inventory consists of: identification and description of landscape units; evaluation of visual variety; evaluation of existing visual condition (EVC); and identification of visual quality objectives (VQO's). The inventory was based on existing USFS data, supplemented where necessary by field evaluation by Dames & Moore. Methodologies and terms used in the analysis are detailed in **Appendix B.**

The proposed well site is included in the Rock Creek Landscape Unit which includes Rock Creek Canyon from its mouth at Point of Rocks to the bend in the valley near Ratine Campground. It is a steep-sided valley corridor, with a gently sloping valley floor. Coniferous forest covers the higher slopes, with contrasting open grassland and sagebrush on the benches. Deciduous trees and riparian vegetation along the banks of Rock Creek provide seasonal color variation. The riparian strip contains many summer homes and access roads which are largely hidden among trees. Downstream (north) from Piney Dell, a substantial number of landscape modifications are apparent, including homes on open ground, water tanks, telephone and power distribution lines, and cut-and-fill scars.

The inherent scenic qualities of the Rock Creek Landscape Unit are generally assumed by the USFS (1981a) to be Distinctive, or Class A (outstanding or above average scenic diversity). However, the inherent characteristics of this portion of the valley correspond more to the USFS (1981) definition of Common, or Class B (diversity of scenery which occurs frequently within the region). Although scenic features (such as the colored rock outcrops at Point of Rocks, contrasting vegetation patterns, and Rock Creek itself) do occur, the unit does not offer the vivid alpine scenery which occurs further up the canyon. EVC ratings (see Table B-1 in **Appendix B**) which describe the level of man-made alteration range from

Disturbed (EVC 4) on the valley floor to Unnoticed (EVC 2) on the mountain sides.

In the Rock Creek Landscape Unit, key viewpoints include: Beartooth Highway (State Highway 212); access roads to residences and summer homes; Red Lodge - Belfrey Highway; recreation facilities, including the Sheridan and Ratine campgrounds, and nearby trails; summer homes; and year-round rural residences. Use volumes vary seasonally, with high recreational and tourist use occurring from May to September. During this period, approximately 300,000 people (about 1,650 per day) travel the Beartooth Highway and the campgrounds and summer cabins and residences are frequently occupied. User concern for scenic quality is estimated to be high for permanent and part-time residents and recreational visitors. Commercial travelers probably exhibit lower levels of concern for scenic qualities of the well site.

Because of its proximity to the frequently traveled Beartooth Highway, the site is considered to have high visual sensitivity. In winter, use of the area is much lower, but sensitivity would still be rated high since a large proportion of viewers would be recreation visitors (such as snowmobilers and skiers) with a high concern for visual qualities.

In the Draft Land and Resource Management Plan for the Custer National Forest, the USFS (1985) established a VQO of "Retention" for USFS lands in the valley floor of the Rock Creek Landscape Unit. The definition of the Retention VQO states that "the intent will be to retain the natural appearing landscape, and development activities will not be evident to the casual forest visitor". Although the USFS' VQO does not apply to private lands, it is indicative of the level of concern for scenic preservation near the site.

Environmental Consequences

The proposed exploration project would introduce a number of temporary structures to a currently undeveloped area. The mast on the drilling rig, approximately 165 feet high, would be most prominent. Other major visual features would include: the bulk of the drilling substructure; cut-banks above the reserve pit; trailers; storage tanks; and associated facilities. The photosimulation of the proposed well site with drilling equipment in place (Figure 2-2) approximates the appearance of the site during late summer.

The wellpad, drilling rig, trailers, storage tanks and other proposed project facilities would be fully visible from Highway 212 for approximately 600 yards south-bound (25 seconds at 50 mph) and 440 yards north-bound (18 seconds at 50 mph). In foreground, the site would have strong visual contrasts for this duration, although it is likely that some tourists would slow down or stop to view it. From other locations on Highway 212 (between Point of Rocks and the bend of Hakel Gulch), only the mast on the drilling rig would be visible above intervening terrain and/or trees. From these views, contrasts would be weak to moderate.

The top of the drilling rig would be seen from approximately ten houses to the north of the site, and from Piney Dell, but contrasts would be weak to moderate due to distance and tree screening. Other facilities on the wellpad would not be visible. Project facilities would not be seen from the Sheridan or Ratine campgrounds and most, if not all, summer homes to the south, due to riparian screening. Middleground or background views may be obtained from the Maurice Creek area.

The visual contrasts of the project would not change the EVC classification of "Disturbed" in the Rock Creek Landscape Unit, since the valley already contains considerable disturbance and strongly contrasting views of the project would be limited. During the drilling period, the project would not meet a VQO of Retention, or even Partial Retention, since it would attract the attention of a large number of viewers. Other structures and modifications on private land in the Rock Creek Landscape Unit do not currently conform to a VQO of Retention.

Visual impacts would be most pronounced during the drilling phase. Visual impacts would be similar during the production testing phase, if required, but somewhat reduced due to the smaller size of the well service rig. Visual qualities may be restored through site restoration and revegetation, depending on the reclamation specifications of the landowner.

Visual impacts as perceived by the public during drilling would probably vary with viewer type. Local residents and repeat visitors to the area may feel that visual qualities had been impaired, regardless of the limited visibility of the project, due to its scale, industrial character, and location at the gateway to natural landscapes and wilderness areas. First time or infrequent visitors may not perceive a reduction in visual qualities and may consider the rig a novel sight.

TRANSPORTATION

Affected Environment

Amoco anticipates that crews and service companies for the proposed drilling and production testing program would commute to the well site from their current bases of operation. These could include Cody, Powell, or Billings. The probable commuting route from Cody or Powell would follow Montana State Highway 72 north to Belfry, Carbon County Road 308 from Belfry west to Red Lodge, and U.S. Highway 212 from Red Lodge southwest to the wellsite. Commuters from Billings would follow Interstate 90 west to the Highway 12 junction and Highway 212 southwest to the site (see Map 1-1).

Average daily traffic (ADT) levels for these routes are summarized in Table 3-3. Over the course of a year, ADT levels fluctuate markedly in the Red Lodge area, with higher levels occurring during the summer tourist season. During peak months, operating conditions on area roads generally fall within Level of Service B criteria (MSDH 1986), indicating a stable traffic condition with operating speeds and vehicle maneuverability starting to become affected by traffic conditions. Level of Service B is the preferred operating condition for major roadways in the area.

The major roads are maintained in good condition by local, state, and county highway departments. State highway crews are responsible for maintenance tasks on U.S. Highway 212 and Montana 72, while Route 308 is maintained by the Carbon County Highway Department. Occasionally, road closures are necessary due to periods of inclement weather, particularly on the higher western reaches of Route 308.

TABLE 3-3
AVERAGE DAILY TRAFFIC COUNTS FOR AFFECTED ROADS

CARBON COUNTY HIGHWAY 308	499
MONTANA HIGHWAY 72	820
U.S. HIGHWAY 212	
Custer National Forest to Red Lodge	750
Red Lodge to Junction Highway 421	1,539
Junction 421 to Joliet	2,050
Joliet to Rockvale	1,893
Rockvale to County Line	4,285
County Line to I-90	5,210

Source: Montana Department of Highways 1986

Environmental Consequences

During all phases of the proposed exploration project, additional traffic would occur on area roads as crews commute to and from the well site and materials and equipment are delivered (see Table 2-1 for transportation requirements). The ADT increases directly attributable to the project would be as follows:

Rigging Up:	27 trucks
Drilling:	5 trucks 16 passenger cars or pickups
Production Testing:	7 trucks 10 passenger cars or pickups

These increases would not significantly affect traffic volumes or change the level of service currently experienced on affected roads and are, therefore, considered insignificant. The increases in heavy truck traffic associated with the project could accelerate the deterioration of road structures and roadbeds.

Minor, temporary traffic slowdowns may occasionally be experienced at the well site if large service or cement trucks arrive simultaneously. Generally, however, traffic impacts would be minimized since service operations and equipment deliveries would be scheduled into the site at varying times of the day. Temporary slowdowns could also occur, especially during summer, if vehicles stop along the roadside to view the drilling activities.

SOCIOECONOMIC CONDITIONS

Affected Environment

The proposed Beartooth Exploration Well would be located approximately 4.5 miles south of the City of Red Lodge, the political and economic center for Carbon County, Montana. Once the center for a booming mining and agricultural economy, Red Lodge now reflects the importance of recreation and tourism in the region. Recreation and retail trade dominate the economy with approximately 34 percent of the City's workforce employed in these sectors (as of the 1980 census). The City's permanent population is estimated to be 1,986 with an additional 600 or so part-time residents who occupy vacation homes on weekends and during the summer. The City's housing supply includes approximately 987 permanent units, with a vacancy rate of approximately 15% (based on the 1980 census). In addition to the permanent units, 240 motel units and a KOA Campground (open during the summer), enable Red Lodge to respond to weekend and summer influxes of tourists and short-term residents. The City provides a full range of community services which are considered adequate for present needs.

Environmental Consequences

Because drilling crews and well service companies are expected to commute to the proposed well site from existing bases of operation in Cody, Powell, or Billings, the proposed exploration program would not significantly affect the City of Red Lodge. Socioeconomic consequences are summarized below:

* **Employment.** Amoco plans to hire a drilling contractor who would supply crews from the Cody, Powell, or Billings area. Some support services may be obtained from Red Lodge.

* **Population.** Drilling crews and other employees would commute daily. No increases in the Red Lodge population are anticipated.

* **Housing.** Drilling foremen, toolpushers, and mud loggers would reside on-site in trailers. Remaining employees are expected to commute and would not impact the City's housing supply. During periods of inclement weather during the proposed winter drilling program, crews may require temporary housing when Route 308 between Cody and Red Lodge is impassable. The large number of motel rooms available in Red Lodge, coupled with the fact that motel occupancy during winter is less than 50 percent, suggests that short-term housing would be readily available.

* **Economy.** No secondary employment responses are expected to occur. The proposed project would be of such short duration that well service contractors are unlikely to relocate operations to Red Lodge. The local economy is geared toward serving large numbers of visitors during the summer and on weekends in winter; the proposed project would not generate any adverse effects on the

local economy. Some positive economic effects would accrue due to retail sales to drilling and service company employees.

* **Community Services and Facilities.** No adverse impacts on facilities or services are anticipated. As noted above, the City has adapted its operations and major facilities to respond to large numbers of short-term and temporary residents. The proposed project would not place any burdens on the City's ability to provide essential services.

* **Fiscal Conditions.** The proposed project would not generate additional tax revenues in Red Lodge. No additional demands for services or facilities are expected to occur; therefore, no additional expenditures are anticipated. Carbon County would receive up to thirty-six thousand dollars in additional property tax revenues from the drilling rig. The exact amount depends on the depth rating of the rig, its age, and the length of time it is actually in place. The county would also receive revenes from license fees for vehicles used in the drilling operation.

HEALTH & SAFETY RISK ASSESSMENT

Introduction

This final section of Chapter Three describes the potential environmental and safety risks associated with an accidental release of formation fluids (gas, oil, or water) from the exploration well. In contrast to the preceding sections of Chapter Three which summarized environmental changes which **would be expected to occur**, this section addresses a rare event which **is very unlikely to occur** with the design and operating practices proposed by Amoco in the APD. Preventing well blowouts is an important concern during drilling and is accomplished by use of experienced drilling personnel; proper casing and cementing; proper design and use of drilling muds; constant monitoring of the characteristics and volume of drilling mud to determine conditions in the wellbore; and equipping the well with blowout preventers which can be used to shut-in the well if needed. Amoco's proposed drilling program exceeds the stringent BLM standards for drilling in areas where hydrogen sulfide (H2S) gas may be encountered (Kruger 1986).

Proper design and operating procedures effectively prevent uncontrolled, accidental releases of formation fluids, in most cases. Although records are not uniformly maintained, available statistics indicate the chance of an uncontrolled release is remote. Lawrence Livermore National Laboratory (LLNL 1983) reviewed Canadian records for gas wells for the period 1960 to 1980 and reported a total of 83 accidental releases out of a total of 35,076 gas wells drilled. These statistics included all accidental releases and thus may overestimate the chance of major releases or uncontrolled blowouts. Montana officials (Rickman 1986) indicated that only one minor blowout had been reported in the state during the last ten years. Similarly, Wyoming officials (Watson 1986) reported that two blowouts had ocurred during the most recent ten-year period, during which more than 12,000 oil and gas wells were drilled in the state (BLM 1985).

Although an accidental release is unlikely to occur at the Beartooth Exploration Well, the potential risks associated with a release were identified as an important concern during the EA scoping process. These are addressed in three subsections following this Introduction. The **Environmental Effects** subsection provides a brief overview of the potential environmental concerns associated with a well blowout. The **Human Health and Safety** subsection focuses in more detail on the potential risks of an accidental release of hydrogen sulfide (H2S) gas during a well blowout. The last subsection summarizes key aspects of Amoco's **Contingency Plan.**

Environmental Effects

Although unlikely, a well blowout could cause unpredictable, and possibly severe, environmental damage near the proposed well site. The extent of environmental damage would depend on the volume and characteristics of the materials released; environmental conditions at the time of the blowout; and on the length of time required to bring the well back under control. Blowouts may last from less than an hour to months (LLNL 1983).

A blowout could release liquid materials (drilling fluids, contaminated formation waters, oil, or natural gas condensate) under pressure. These liquids could be spread some distance from the well site, where they could contaminate soils, vegetation, and surface water. Depending on the volume released and the area contaminated, degradation of soils or water quality could result, requiring intensive clean-up and reclamation efforts.

A well blowout could also release methane, carbon dioxide, hydrogen sulfide and other gases to the atmosphere. If fires accidentally occurred, or if the well was intentionally set on fire for safety reasons, sulfur dioxide would be produced. These gases would degrade air quality. Accidental fires, or the gases themselves, could damage vegetation, depending on the characteristics and duration of the gas release. If present in sufficient quantities, hydrogen sulfide gas could be hazardous to humans and wildlife in the vicinity of the well. H_2S is toxic to animals and could kill elk, deer, and other animals if high concentrations occurred. Estimates of lethal concentrations for wildlife range from 200 to 2,000 ppm depending on species and duration of exposure (LLNL 1983). Human health and safety would also be a serious concern, as described later in this section.

A blowout would be treated as an emergency situation and could require road closure, campground closure, and evacuation of residents or visitors near hazardous areas. Recreational and residential uses near the well would be disrupted until the well was controlled. Depending on the nature of the blowout and the extent of impact, recreation use and/or quality could be reduced over the long-term, while clean-up and reclamation procedures are implemented.

Human Health and Safety

Although H_2S is one of the potential emissions from a well blowout, it must be stressed that the likelihood of occurrence of H2S is unknown and H_2S may not be encountered in the proposed Beartooth Exploration Well. However, because of the concern expressed during scoping, this section specifically addresses and quantifies the H_2S-related risks associated with the proposed drilling program, assuming H_2S to be present.

The public health risks of operations involving H_2S gas depend primarily on the characteristics of any atmospheric gas releases that may occur (i.e., the emission rate, duration, and effective height of the release) and characteristics of the resulting population exposures (i.e., ambient H_2S concentrations, duration of inhalation, the size of the affected population, and individual susceptibilities). Hydrogen sulfide (H_2S) gas is a highly toxic gas that will disassociate itself from a natural gas stream in which it is mechanically mixed and tend to sink in the atmosphere due to its high specific gravity. The gas is, however, wind sensitive, and will be readily carried and diluted by winds.

A summary of the toxic effects of hydrogen sulfide on humans is presented in Table 3-4 . As indicated in Table 3-4 , H_2S at different concentrations has varying effects on humans. The principal safety concern of H_2S is the potential for acute health effects, including respiratory arrest, unconsciousness, and possibly death. A reasonable threshold concentration for acute effects is about 300 parts per million (ppm) over a time period of approximately 10 minutes (LLNL 1983). Threshold Limit Values for H_2S in the work environment have been established by the American Conference of Governmental Industrial Hygienists (ACGIH). ACGIH has established Threshold Limit Values of 10 ppm Time Weighted Average (TWA) and 15 ppm Short Term Exposure Limit (STEL). Basically for the TWA, nearly all workers could be repeatedly exposed 8 hours per day and 40 hours per week to 10 ppm without adverse effects. However, worker exposures at the STEL (15 ppm for H_2S) should not be longer than 15 minutes and should not be repeated more than four times every day.

A detailed air quality and risk analysis was completed to quantify the health and safety impacts associated with an accidental release of gas containing H_2S. The analysis was completed following the procedure developed by the Lawrence Livermore National Laboratory for the Bureau of Land Management and set forth in Accidental Releases of Sour Gas from Wells and Collection Pipelines in the Overthrust Belt: Calculating and Assessing Potential Health and Environmental Risks, (LLNL, 1983). The LLNL procedure was augmented by atmospheric dispersion modeling of H_2S emissions using a model that includes the effect of local topography on ground level concentrations. See **Appendix B, Methodologies**, for more detail.

TABLE 3-4

EFFECTS OF H_2S GAS ON HUMANS

CONCENTRATION[a] ppmv	CONCENTRATION[a] mg/m^3	EXPOSURE TIME (SEC)	EFFECT
2000[b]	2880	3-10	Respiratory arrest, unconsciousness, pulmonary edema, or death
500-1000[b]	720-1440	3-120	Respiratory arrest, unconsciousness, pulmonary edema, or death
250[c]	360	1220	Unconsciousness
150-250	216-360	--	Loss of sense of smell
50-500	72-720	--	Respiratory irritation
10-20	14-28	--	Eye irritation
0.005	0.007	--	Median odor threshold

Sources: LLNL 1983, ACGIH 1980.

[a] For a pressure of 1 atm and a temperature of 60°F.

[b] Animal data.

[c] Based on one incident.

The analysis assumed an extreme H_2S blowout situation combined with worst-case meteorological conditions. Results of the analysis indicated that with a worst-case blowout, the H_2S concentrations would exceed 300 ppm concentrations for an area about a mile surrounding the drill site. This would encompass an area from just north of Piney Dell to the Sheridan Campground area. Beyond this area, worst-case H_2S concentrations were predicted to be below the 300 ppm threshold for acute effects. Modeling results indicated that under certain conditions, low H_2S concentrations could reach Red Lodge. These could be sufficient to cause eye irritation, but would be well below hazardous levels.

It must be stressed that the modeling analysis followed the approach suggested by LLNL. Actual concentrations could be more or less than predicted. However, since the LLNL approach is designed to be conservative, actual H_2S concentrations would probably be lower than predicted.

The final step in completing the air quality risk analysis is to estimate the actual probability of risk to the population in the area of the proposed well site. In completing the risk assessment (see Appendix B), H_2S concentrations predicted by the model were used with meteorological conditions at each specific receptor and the probability of an accidental release to calculate the total risk (joint frequency of occurrence) at a specific point.

The probability of accidental releases, including blowouts, estimated by LLNL was used in this analysis. This includes any accidental, uncontrolled release of gas to the atmosphere and therefore may overestimate the probability of a hazardous blowout. LLNL's estimate was based on Canadian statistics for 1960 to 1980 when a total of 35,076 gas wells were drilled in Canada and 83 accidental releases occurred (LLNL 1983). Thus the probability of an accidental release actually occurring was assumed to be 0.0024, or about 1 chance in 423 for each gas well drilled.

Comparative published statistics for the Beartooth region are unavailable, however, information provided by Amoco (1986) suggests the LLNL statistics may overestimate the blowout probability. Surveys of the four major drilling companies operating in the Rocky Mountain area indicated that over 3,100 H_2S wells have been serviced, with one H_2S blowout. In its Wyoming Districts (which encompass parts of Utah and Colorado and all of Wyoming, Montana, and North Dakota), Amoco has drilled 1,475 wells with no blowouts (Amoco 1986).

The area of risk to the human population would generally be limited to the area inside the 300 ppm area which was previously described. Based on the LLNL (1983) accidental release statistics, the risk probability of a human being exposed to H_2S concentrations that could cause an acute health response, including death, was calculated to be approximately 0.000062 (about 1 chance in 16,000) in Piney Dell and approximately 0.0000046 (about 1 chance in 220,000 in the Sheridan Campground.

This risk of an H_2S fatality would be about the same or slightly more than the risk of death from a natural disaster like lightning or tornadoes (LLNL 1983). Table 3-5 provides a list of comparable risks for various activities.

Contingency Plan

Because there is a possibility that H_2S may occur in formations to be penetrated by the exploration well, Amoco has developed a draft H_2S Contingency Plan (Envirosafe 1986) which defines the H_2S safety measures to be employed during drilling and production testing operations. The contingency plan is required by BLM and must be approved, as a separate action, prior to drilling. The draft contingency plan will also be reviewed by local officials before it is finalized.

As previously summarized in Table 2-3, the plan describes equipment and procedures to be used to assure worker safety on the drilling site. These include placement of H_2S monitors at critical locations around the drilling rig. The monitors would be set to trigger a visible and an audible alarm if H_2S concentrations above 10 ppm are detected. Additional measures include placement of respirators for drillers' use, increasing the pH of the mud so that any H_2S bound in the mud would disassociate into sulfide and hydrogen ions, and addition of compounds to remove H_2S from the mud.

TABLE 3-5

ANNUAL INDIVIDUAL RISK OF DEATH FROM VARIOUS ACCIDENTS AND NATURAL DISASTERS

Risk Producing Activity	Population Deaths Per Year Risk	 Odds
Smoking (20 Cigarettes/Day)	0.005	1 in 200
Automobile	0.00025	1 in 4,000
Industrial	0.00017	1 in 6,000
Falls	0.000077	1 in 13,000
Fire and Burns	0.00004	1 in 25,000
Airplane Crashes	0.0000077	1 in 130,000
Lightning	0.0000005	1 in 2,000,000
Tornadoes	0.00000044	1 in 2,300,000

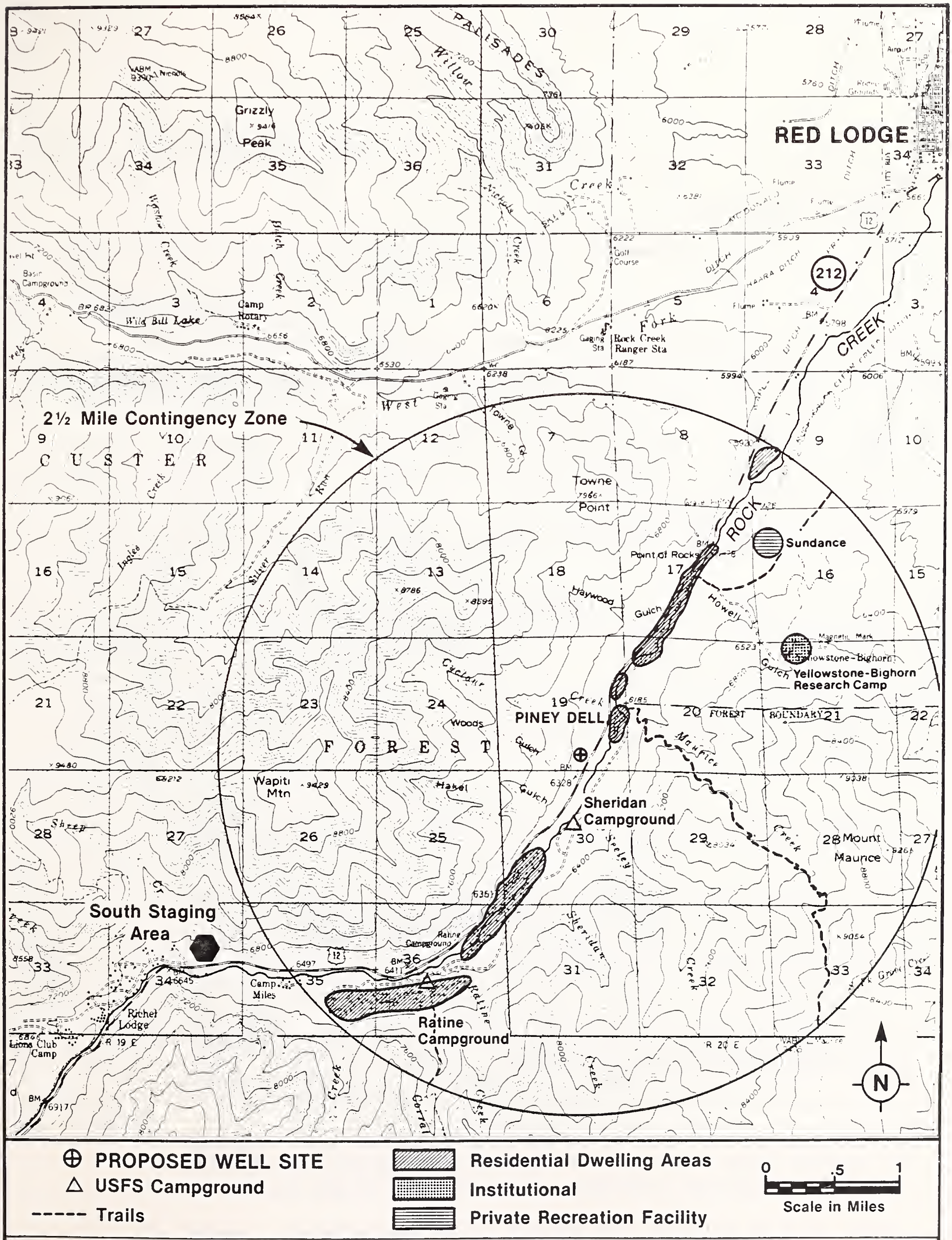
Source: Atwell and Andrews 1979.

The contingency plan also includes a series of measures designed to assure the safety of area residents and visitors in the event of a major leak or blowout of the well. These potential measures include flaring the well to burn the hazardous H_2S and the methane to form a hot mixture of SO2 and air that would readily volatize and disperse due to its heat-generated buoyancy. Contingency plans also include measures to alert potentially affected residents in the event of emergency conditions (defined as an uncontrolled flow from the well) and, if needed, to evacuate all persons within a 2.5 mile radius of the well (Map 3-5).

The 2.5 mile contingency zone includes: the Grizzly Condominiums, Rock Creek Mine, and other commercial development at Piney Dell; the USFS' Sheridan and Ratine campgrounds; the Yellowstone-Bighorn Research Camp; and approximately 167 homes and cabins. Most of the residences and recreation sites within the contingency zone are used primarily during the summer season, from Memorial Day to Labor Day. The Carbon County Sheriff's Department estimates that fewer than 20 of the homes in the zone are regularly occupied during winter.

In the event of a blowout requiring evacuation, persons north of the well would be advised to immediately evacuate to Red Lodge. Persons south of the well would be advised to move to a safe staging area south of the well (Map 3-5) to await helicopter evacuation. Because the area's human population increases markedly from winter to summer, summer evacuation would require greater manpower and logistical support. Under Amoco's proposed schedule, drilling would not be conducted during the peak recreation and tourist seasons. Contingency plans were developed for both drilling periods, however, in case drilling should extend into the high use period.

Evacuation, if needed, would be directed by the Carbon County Sheriff's Department, assisted by other County emergency personnel and by Amoco personnel. The draft contingency plan was developed with input from County personnel. The draft will be reviewed with County personnel and revised to meet their approval prior to finalization.



Map 3-5 Health and Safety Contingency Zone

CHAPTER FOUR

COMPARATIVE ANALYSIS

RESOURCE COMPARISON

The environmental analyses in Chapter Three described the projected consequences of implementing the proposed Beartooth Exploration Well. Where appropriate throughout the impact discussions, seasonal impact considerations were described to identify the differences in impact between Amoco's proposed fall-winter project schedule and the alternative spring-summer schedule **(see Figure 2-3).** This section summarizes the impact conclusions to highlight the trade-offs between the alternative drilling schedules.

Many of the projected impacts of the Beartooth Exploration Well are independent of the drilling season. That is, they are physical changes in the environment (e.g., surface disturbance, consumptive water use) that would occur whenever the well was drilled. Impacts on those resources that are unaffected by seasonal drilling considerations are summarized below:

* Air Quality. The proposed project would result in minor temporary adverse effects on air quality from fugitive dust and combustion emissions.

* Noise. Amoco would equip the drilling rig with mufflers to minimize noise levels. Drilling rig noise would be expected to be below EPA guidelines (50-55 dBA) within 100 feet of the rig. The remaining low-level background noise may be perceptible at Piney Dell, Sheridan Campground, and other locations in the vicinity.

* Topography. Site preparation would require leveling of 2.75 acres using standard cut-and-fill construction techniques. This area may be regraded upon abandonment, depending on the desires of the private landowner.

* Geology. The drilling program would explore the hydrocarbon potential of several deep geologic formations. Small volumes of oil and gas may be removed during production testing.

* Soils. Construction would disturb soil profiles on 2.75 acres.

Topsoil would be salvaged from the well site, prior to construction, and stockpiled for future use in revegetating the site.

- Ground Water. Ground water pumping for drilling mud make-up would not impact other water users or significantly affect flow in Rock Creek. Ground water contamination would be limited by design aspects of the wellbore (e.g., use of a BLM approved casing program) and by installing an impermeable liner in the reserve pit.

- Surface Water. The proposed construction activity would result in temporary, insignificant changes in flow in Rock Creek. Water quality would not be affected.

- Aquatic Resources. The proposed drilling program would not affect fisheries in Rock Creek.

- Vegetation. Wellpad construction would remove 2.75 acres of vegetation. Depending on landowner desires, the site may be recontoured and revegetated upon abandonment.

- Threatened and Endangered Species. The project would not affect threatened and endangered species.

- Cultural Resources. No cultural resource impacts are anticipated.

- Land Use. The project would temporarily convert 2.75 acres of rangeland to industrial use. The area would remain in industrial use only if significant oil or gas reserves are discovered. The drilling activities would not affect existing off-site land uses.

- Socioeconomic Conditions. The proposed exploration well would not significantly affect the City of Red Lodge or Carbon County. Carbon County would receive additional tax revenues for the period in which the drilling rig is in place.

In contrast, impacts on Wildlife, Recreation, Visual Resources, Transportation, and Health and Safety have a strong seasonal aspect and would vary, depending on the drilling schedule selected. These variations stem from the seasonal differences in human population levels in the area; during the summer period, many more tourists, weekend visitors, and part-time residents occur in the area. Thus, the alternative spring-summer drilling schedule would increase recreation, visual resource, transportation, and health and safety concerns, simply because there are more people in the area. Similarly, the proposed drilling schedule would overlap deer and elk winter range use periods for a longer period of time.

Seasonal aspects of these impact concerns are summarized below:

- * Wildlife. The project would physically remove 2.75 acres of elk and mule deer winter range. Noise and human activity at the site could reduce big game use of adjacent areas, depending on drilling timing and weather conditions. The affected area would be small (less than 20 acres) and would not significantly affect the well-being of the elk and deer herds.

- * Recreation. The project would not affect existing recreation opportunities. Some recreationists may perceive a reduction in recreation quality if they view the drilling program as inappropriate for the area; others may perceive an enhanced recreational experience if they consider the drilling rig an interesting or novel sight. Far more recreationists would be affected during the alternative drilling schedule since it overlaps the peak recreation season. The proposed fall-winter schedule would miss the major recreational use period.

- * Visual Resources. Seasonal aspects for visual resources are similar to those of recreation. The drilling site would be highly visible from Highway 212 and would strongly contrast with surrounding areas. People's reactions to the drilling rig would vary, depending on their perspective; however, many more people would be exposed to the operation during the alternative spring-summer drilling program.

- * Transportation. Project-related traffic would be similar for both drilling seasons. The potential for traffic slowdowns on Highway 212 would be higher with the alternative drilling schedule, since traffic volumes are higher during summer. Traffic is minimal on Highway 212 during much of the proposed fall-winter drilling period because the road is closed by snow, about 5 miles south of the site.

- * Health and Safety. The chances of a well blowout and the accidental release of hazardous substances are independent of drilling season. However, the proposed drilling schedule occurs after the peak tourist season and consequently minimizes the number of people potentially in the vicinity. An accidental release of H_2S during the spring-summer tourist season would potentially expose a larger number of people to H_2S and would require greater efforts to alert and evacuate the population within the contingency zone.

In summary, the physical impacts of the proposed drilling and production testing program do not change between drilling seasons. The human and wildlife populations of the area do change seasonally and thus, impacts on human and wildlife resources may be sensitive to drilling schedules.

NO ACTION ALTERNATIVE

If the No Action Alternative were selected, the impacts described in **Chapter Three** and summarized above would not occur. Amoco's proposal to evaluate the hydrocarbon potential of the Federal Minerals Lease M-38867 would be delayed, at least temporarily.

As noted in **Chapter Two**, BLM's authority to implement the alternative is limited by lease rights. BLM could disapprove Amoco's APD if it would violate lease stipulations or applicable federal laws or regulations. If BLM disapproved the APD, Amoco could modify its proposal and resubmit an application to drill in the same location.

CHAPTER FIVE

BENEFITS, TRADE-OFFS, AND COMMITMENTS OF RESOURCES

UNAVOIDABLE ADVERSE IMPACTS

The environmental impact analyses in **Chapter Three** assume that the resource protection considerations outlined in **Chapter Two** (pages 2-13 to 2-15) would be implemented. No other mitigation measures have been committed to at this time. Thus, the impacts described in Chapter Three are all considered unavoidable. As discussed in the comparative analysis in **Chapter Four**, certain impacts are sensitive to changes in drilling schedule and could be minimized, but not totally eliminated, by timing constraints on the drilling schedule.

BENEFITS

The purpose of the proposed Beartooth Exploration Well is to determine the hydrocarbon potential of previously unexplored geologic formations. The benefit of the proposed project would be the discovery of additional domestic oil or gas reserves, if the exploration program is successful. Thus, the benefits of the proposed project would accrue in the future, and are conditional, depending on drilling results, economic conditions, and future plans (if any) to produce oil or gas.

TRADE-OFFS

The possible future benefit of additional oil and gas reserves involves trade-offs with the existing environment. Implementation of the proposed exploration program would require short-term disturbance of 2.75 acres of private land and temporary increases in noise levels, traffic, human activity, and visual contrasts. Depending on the outcome of the drilling program and landowner requirements, reclamation efforts would restore the site to productive rangeland and wildlife habitat within a few years following abandonment. No long-term impacts are anticipated to result from the proposed exploration program. If production is established, further NEPA documents will address the environmental impacts of field development and production.

COMMITMENT OF RESOURCES

The proposed project would involve short-term or temporary resource commitments. The only irretrievable resource commitments involved in the project would be the fuel, drilling muds, and other supplies used during drilling. Site disturbances and other projected impacts are reversible.

CHAPTER SIX

CONSULTATION AND COORDINATION

ENVIRONMENTAL ASSESSMENT TEAM

This Environmental Assessment (EA) was prepared by an interdisciplinary team from Dames & Moore, an environmental and engineering consulting company from Fort Collins, Colorado. Table 6-1 provides a list of the personnel responsible for document preparation, their qualifications, and assignments.

A draft of the EA was reviewed and approved, prior to publication, by personnel from the BLM, Miles City District Office and USFS, Custer National Forest.

PUBLIC PARTICIPATION

There were many opportunities for public participation and agency coordination throughout the EA process. These included the following: (1) on-site inspection; (2) public information meeting; (3) public scoping meeting, and (4) meetings or telephone contacts with state, federal or local agency personnel to obtain information. These are discussed in more detail in the following paragraphs.

On-site Inspection and Meeting

On October 24, 1985, a meeting was held at the proposed well site with representatives from the USFS, BLM, Amoco, and the surface landowner. The purpose of the on-site visit was to thoroughly examine the proposed operation and develop methods to lessen the potential adverse impacts.

Information Meeting

On November 7, 1985, approximately 60 people participated in an informal public information meeting in Red Lodge, Montana. The purpose of the meeting was to provide general background on the project and gain

TABLE 6-1. LIST OF PREPARERS

NAME	EA ASSIGNMENT	EDUCATION	YEARS OF ENVIRONMENTAL EXPERIENCE
Dames & Moore			
Robert McDonald	Project Manager	B.S., Fisheries Science; M.S., Natural Resources Administration, Colorado State University	20
Thomas Shoemaker	Assistant Project Manager	B.S., Biology and English, Lewis and Clark College; M.S. (Candidate) Wildlife Ecology and Natural Resource Planning, Colorado State University	9
Tom Eaman	Principal Investigator--Soils	B.S., Range Management, Colorado State University; M.S., Range Management, Texas A & M University	35
Loren Hettinger	Principal Investigator--Vegetation	B.S., Biology, Ft. Lewis College; M.S., Biology-Botany, New Mexico State University; Ph.D., Plant Ecology, University of Alberta	15
Anand Prakash	Principal Investigator--Water Resource	B.S., Civil Engineering, University of Roorkee, India; M.S., Irrigation/Hydraulics, University of Roorkee, India; Ph.D., Civil Engineering, Colorado State University	26

TABLE 6-1. List of Preparers (Continued)

NAME	EA ASSIGNMENT	EDUCATION	YEARS OF ENVIRONMENTAL EXPERIENCE
Rich Boyd	Principal Investigator--Air Quality & Risk Analysis	B.A., Chemistry, Southern Illinois University; Graduate Studies, Meteorology, New York University; M.B.A. Business, Southern Illinois University; Certified Consulting Meteorologist	17
Raylan Roetman	Air Quality Technician	B.S., Environmental Science and Chemistry, Northern Arizona University; M.S., Atmospheric Science, Colorado State University	2
Zenas Bliss	Principal Investigator--Noise and Geology	B.S., Geology, Northeastern University-Boston; M.E. (candidate), Geological Engineering, Colorado School of Mines	7
Barbara Lewis	Principal Investigator--Public Involvement	B.A., Economics, Colorado College M.S., Water Resources Management, University of Wisconsin-Madison	4
Cameron Gloss	Principal Investigator--Land Use	B.S., Geography, Arizona State University	2
Stephen Sheppard	Principal Investigator--Visual Resources and Recreation	B.A. and M.A., Agricultural and Forest Sciences, University of Oxford; M.S., Forestry, University of British Columbia-Vancouver; Ph.D., Environmental Planning, University of California-Berkley	12
Martha Goodavish	Visual/Recreation Resource Specialist	B.A.L., Landscape Architecture, University of Oregon	10

TABLE 6-1. List of Preparers (Continued)

NAME	EA ASSIGNMENT	EDUCATION	YEARS OF ENVIRONMENTAL EXPERIENCE
Karen Bow	Principal Investigator--Regulatory Reconnaissance	B.S., Environmental Biology, Colorado State University	9
Karen Watkins	Project Coordinator--Assistant	B.S., Outdoor Resource Management; University of Wyoming; M.S. (candidate), Forest Economics and M.B.A. (candidate), Colorado State University	2
Sub-Contractors			
Michael Busdosh	Principal Investigator--Aquatic Resources	B.S., Zoology, Arizona State University; Ph.D., Biology, University of Louisville	14
Harold Picton	Principal Investigator--Wildlife	B.S. and M.S., Fish & Wildlife Management, Montana State University; Ph.D., Comparative Physiology, Northwestern University	25
George Blankenship	Principal Investigator--Socioeconomics	B.A., Anthropology, University of Nebraska; B.A., Social Work, Colorado State University; M.S., Planning and Community Development, University of Colorado	7
Jed Goldstein	Socioeconomics	B.A., Sociology, University of Massachusets; M.A., Planning, University of Colorado	6
Ken Kucera	Principal Investigator--Transportation	B.A., Geography; M. A., Urban Planning, University of Colorado	5

information on local concerns and questions regarding the proposed operation. Issues and concerns raised at this meeting were:

* Effects on Silver Run Elk Herd;
* Health and Safety of Residents and Visitors;
* Impacts on Recreational Activities;
* Preservation of Water Quality;
* Noise Impacts;
* Effects of Transportation of Equipment; and
* Visual Impacts.

Formal Scoping Process

Based on information received in the information meeting, BLM decided to conduct a formal public scoping process for the EA. On November 25, 1985, a Notice of Intent to prepare an Environmental Assessment and to hold a scoping meeting was published in the Federal Register. A news release and public notice announcing the public meeting was issued in the Carbon County News, the Beartooth Weekly News, and the Billings Gazette.

A fact sheet describing the project and public involvement process was mailed to 15 agencies and 547 individuals and organizations. The mailing list included many property owners within the study area, all persons who attended the information meeting, and names from the Forest Service and BLM mailing lists. The agencies reviewing the Fact Sheet included:

* Montana Department of Fish, Wildlife & Parks;
* Montana Department of Health & Environmental Sciences;
* Montana Department of Highways;
* Montana Oil & Gas Conservation Division;
* Montana Department of State Lands; and
* Army Corps of Engineers.

On December 12, 1985, approximately 30 people attended the Scoping Meeting in Red Lodge, Montana. The purpose of the Scoping Meeting was to identify public issues, concerns, and questions to be considered in the preparation of the EA. Many of the same issues and concerns identified in the information meeting were discussed. The major issues and concerns identified were:

- Impacts of Subsequent Oil and Gas Development if Exploration Activities are Successful. Questions were raised concerning additional environmental analysis for future development activities and long-term impacts.

- Environmental Review Process. Participants requested information regarding the BLM review and public comment process.

- Water Quality Impacts. Impacts of potential pollution from drilling activities on Rock Creek.

- Visual Impacts/Effects on Quality of Life. Concern for the visual impact of the well on tourists and residents in the canyon.

- Adequacy of Public Notice. Concern that the scoping meeting was not widely publicized in local newspapers.

- Need for the Project. Questions concerning the need for more oil and gas wells and whether short-term gain is worth the long-term risks.

- Health and Safety. Assurance of a contingency plan covering all possible hazards and compliance with safety stipulations.

- Economic Issues. Economic gains of the local economy from drilling versus economic losses in the tourist industry.

Written comments were received by the BLM and Dames & Moore until December 27, 1985. The information from the two public meetings and written correspondence was considered in preparation of the EA. Table 6-2 summarizes the questions and issues raised by the public during the EA process.

AGENCY CONSULTATION AND COORDINATION

The Montana Department of Fish, Wildlife & Parks provided baseline wildlife and fisheries information. In addition, there were several meetings with the Department to obtain specific input regarding fish and wildlife concerns for the proposed project.

TABLE 6-2

PUBLIC RESPONSES TO THE PROPOSED BEARTOOTH EXPLORATION WELL

ISSUES	INFORMATION MEETING[1]	SCOPING MEETING (NUMBER)	WRITTEN RESPONSES[2] (NUMBER)
Adequacy of Public Notice		3	
Environmental Review Process	NA	10	1
Need for the Project		3	3
Environmental Impacts	NA	1	8
Health and Safety	NA	6	10
Economic Issues		2	9
Visual Impacts/Effects on Quality of Life	NA	3	6
Tourism/Recreation Impacts	NA	1	10
Wildlife Impacts	NA	1	8
Water Quality Impacts	NA	3	5
Impacts of Development if Exploration is Successful	NA	16	6

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[1] Numbers are not available.

[2] Written responses showed: 12 - For APD; 9 - Against APD; and 3 - Neutral.

The U.S. Fish & Wildlife Service provided a list of threatened and endangered species potentially occurring in the study area. Potential effects on these species are considered in this EA.

Other agencies who were consulted and who provided information necessary to complete the document were:

* U. S. Forest Service

* Montana Department of Health & Environmental Sciences
  --Air Quality Bureau
  --Water Quality Bureau

* Montana Department of Highways

* Montana Department of Natural Resources & Conservation
  --Water Rights Bureau

* Carbon County Planning Office

* Carbon County Sheriff's Office

* Carbon County Assessor

* Carbon County Historic Preservation Society

* Red Lodge Police Chief's Office

* Red Lodge City Clerk Office

* Red Lodge Water & Sewer Department

* Red Lodge Chamber of Commerce

APPENDIX A

FUTURE DEVELOPMENT AND PRODUCTION

As previously noted in the Introduction to the EA, Amoco is seeking federal and state approvals only for drilling and production testing of a single exploration well. BLM's current review and decision-making process applies only to the proposed well, as specified in Amoco's Application for a Permit to Drill, Drilling Program, and Surface Use and Management Plan.

Potential cumulative effects of additional exploration wells, future production wells, and associated oil and gas production facilities were identified as an important public concern during the public scoping process for this EA. This Appendix provides a brief discussion of the possibilities, and limitations, for future development proposals that could occur if the exploratory drilling program is successful in discovering commercial quantities of oil or gas. Additional discussion and environmental analyses of the BLM oil and gas leasing program are provided in a document entitled Oil and Gas Environmental Assessment of BLM Leasing Program, Lewistown District published in September 1981. This document describes oil and gas leasing and the associated environmental effects for the Billings Resource Area in the BLM's Miles City District.

DISCOVERY PROBABILITY

Amoco's proposed Beartooth Exploration Well is classified as a "rank wildcat" well since it would be the initial well drilled in the proposed Beartooth Federal Unit. Nationally, during the years 1980-1984, approximately 28 percent of all exploration wells successfully encountered oil or gas (U. S. Energy Information Administration 1985); during the same period, the success rate in Montana was approximately 27 percent (Rickman 1986). These statistics include all exploration wells and probably overestimate the chance of success for a rank wildcat well. Thus, there is a high probability that the proposed Beartooth Exploration Well would not lead to further proposals for drilling or other oil and gas development.

WELL DEVELOPMENT

If the Beartooth Exploration Well does discover hydrocarbon reserves, Amoco would evaluate the commercial potential of the well during the production testing phase of the project. Depending on the outcome of the testing program, Amoco may choose to permanently plug the well and abandon the location; temporarily seal the well until decisions are reached regarding future production options; or proceed with installation of on-site production equipment. The type of production testing equipment installed would depend on whether the well produces oil or gas; the anticipated volume of production; and Amoco's plans regarding further development of the field defined by the exploration program.

Based on the depth of potential pay zones identified for the exploration well, the well could produce gas or oil. Typical equipment requirements for a producing gas well would include: (1) the "Christmas tree" or series of control valves used to regulate gas flow; (2) a separation unit for separating gas from water, condensate, or oil; (3) a compressor for pressurizing storage of gas and other produced fluids. Typical equipment requirements for a producing oil well would include: (1) the "Christmas tree"; (2) a separator; and (3) storage tanks. These facilities would be installed on the existing wellpad and maintained throughout the productive life of the well. Additional surface disturbance at the well site would not be required.

Amoco's plans for production at the Beartooth Exploration Well would be communicated to the BLM in the form of a Sundry Notice. BLM would review the notice to assure compliance with lease stipulations and applicable laws and regulations. Separate environmental analyses would be completed to describe the anticipated environmental impacts of production and aid the agency's decision-making.

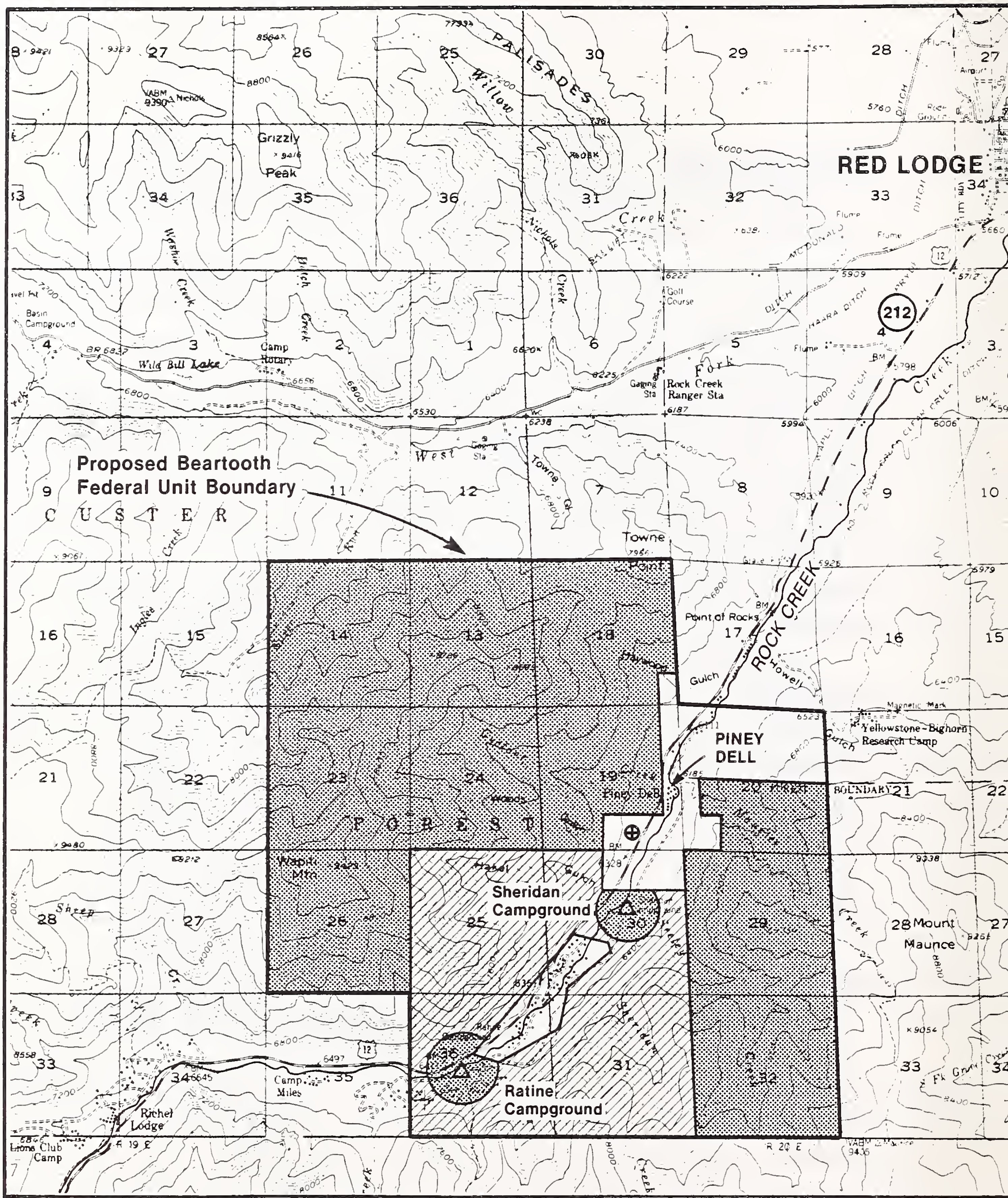
FIELD DEVELOPMENT

Discovery of commercially viable oil and gas reserves could lead to additional proposals for oil and gas development in the vicinity of the proposed Beartooth Exploration Project. Proposals directly resulting from the findings of the Beartooth Exploration Well would be restricted to specific activities or facilities needed to further explore, or produce hydrocarbon products from the proposed Beartooth Federal Unit (Map A-1). The proposed Unit includes several federal and private oil and gas leases which, based on geologic evidence, probably comprise the same oil and gas reservoirs. Although the leases are held by several companies and individuals, the proposed unit agreement assures that all development and production activities would be coordinated and consolidated. As operator of the proposed Unit, Amoco would be responsible for preparing further development proposals and obtaining the required permits and approvals.

Field development within the proposed Beartooth Federal Unit would be governed by the terms of the federal and private lease agreements. Special stipulations applied to several of the federal leases would importantly influence future development plans. In particular, No Surface Occupancy (NSO) stipulations would limit surface developments to less than half of the geographic area included in the Unit (Map A-1). Surface disturbing activities would be precluded within the areas identified as NSO. Surface development in the remaining areas may be possible, subject to the approval of the USFS or private landowner. The USFS or private landowner may apply additional stipulations which would further limit surface occupancy.

Specific proposals for future oil and gas development would be based on Amoco's evaluation of the drilling and production testing programs currently proposed. In a general sense, full development of the proposed Unit would involve construction, operation, and abandonment of facilities needed to efficiently produce, process, and transport the hydrocarbon reservoirs within the proposed Unit area. Specific components which may be included in a development plan include the following:

* Confirmation Well. An additional exploration well could be required to further evaluate and confirm the hydrocarbon potential



⊕ **PROPOSED WELL SITE**

☐ **Private Land**

▩ **Forest Service Land with NSO Stipulation**

▨ **Forest Service Land with Potential Surface Occupancy**
(May be subject to additional limitations)

0 .5 1
Scale in Miles

N

Map A-1 Future Development Limitations

of the proposed Unit. A confirmation well would involve a program similar to that currently proposed by Amoco, but in a different location within the field, depending on the characteristics of the reservoir discovered and the surface resource protection needs.

* Production Wells. Many oil and gas fields require more than one well to efficiently drain the hydrocarbon reservoirs. Well density and location are designed to efficiently produce the natural resource, based on specific reservoir characteristics, economics, and environmental considerations such as NSO stipulations. Most of the information required to determine appropriate well density and locations is not available until after the reservoir has been penetrated and production characteristics have been established. Within the proposed Beartooth Federal Unit, the ultimate well density would be decided only after a discovery of hydrocarbons. The well density proposed at that time would be subject to the approval of the BLM authorized officer, considering all pertinent information.

* Pipeline. Full field development could also require construction of a pipeline system to gather produced oil or gas from production wells and transport it to a storage or treatment facility and from there to existing oil or gas distribution systems.

The location, size, and design of these potential facilities cannot be described without additional information on the characteristics of the hydrocarbon reservoirs that may exist within the proposed Unit. As previously stated, the purpose of the exploration well currently under consideration is to determine the existence and characteristics of potential hydrocarbon reservoirs. If additional facilities are proposed, they would be subject to further environmental review, as outlined below.

ENVIRONMENTAL REVIEW

BLM regulations and the proposed Beartooth Federal Unit Agreement require that a conceptual development plan be prepared to describe the additional wells and other facilities that would be required for full field development, if a commercial hydrocarbon discovery is made. As operator of the proposed Beartooth Federal Unit, Amoco would formulate the conceptual development plan for submittal to BLM and other federal and state agencies, as appropriate, for technical and environmental review and approval.

As part of the federal approval process, future proposals for further oil and gas development activity on the Beartooth Unit would be subject to the environmental analysis requirements of the National Environmental Policy Act (NEPA) and the implementing regulations of the Council on Environmental Quality. Thus, once a conceptual development plan was submitted by Amoco, BLM would complete a full environmental analysis on all aspects of the field development proposal. As required by NEPA, the environmental review would include a formal process for identifying public and agency concerns regarding the proposal. The environmental analysis would specifically address the potential environmental impacts of the proposal and its alternatives. The environmental analysis would be documented in an Environmental Assessment or an Environmental Impact Statement, depending on the scope of the proposal, which would be distributed for public and agency comment, as part of the BLM's decision-making process.

Proposed development activities for the Beartooth Unit would also be subject to various permitting and approval processes by Montana state agencies. Depending on the nature and extent of the conceptual development plan, field development activities may require preparation of a State EIS under the Montana Environmental Policy Act. The State EIS would probably be coordinated with the Federal environmental review process.

APPENDIX B

METHODOLOGIES

Appendix B summarizes the data sources and methodologies used to prepare the environmental analyses included in the text of the EA. In general, existing regional data were used to characterize the affected environment of the well site and surrounding vicinity. These data were supplemented by interviews with federal, state, and local officials and by site investigations or reconnaissance by most project team members. Impact assessment methodologies varied among disciplines depending on the complexity of the issues. Methodologies ranged from qualitative evaluation of potential impacts to detailed modeling investigations, as summarized in the following sections.

AIR QUALITY

Climatic data were obtained from the Climatological Summary for Red Lodge (U.S. Department of Commerce, undated). Existing air quality data were taken from USDA (1977). Impact analyses were based on qualitative evaluations of the project and previous environmental analyses of similar proposals. Detailed modeling studies were completed to assess H_2S concentrations and associated health risks, as described below under **Health and Safety Risk Assessment.**

NOISE

The noise analysis was based on ambient noise level measurements collected by Dames & Moore during November, 1985. Noise measurements were collected at and near the proposed drill site to estimate existing conditions. Additionally, noise measurements were taken near an operating drilling rig to provide a comparative basis for the impact analysis.

Monitor Locations

Twelve monitor locations in Rock Creek Valley were selected for a baseline sound level evaluation. Monitor locations extended from the entrance to Westminster Spires Church Camp north through the valley to the USFS Ranger Station outside of Red Lodge. Monitor locations were selected to characterize sound levels throughout the study area and at specific noise sensitive receptors potentially affected by the proposed drilling program. Monitor locations included Westminster Spires Church Camp, Ratine Campground, Sheridan Campground, Woods Gulch (big game winter range), and Piney Dell. Additional measurements were taken at cabin sites adjacent to the USFS access road between Ratine Campground and Piney Dell and at sites adjacent to Highway 212.

In addition to measurements of ambient noise conditions in the Rock Creek Valley, sound level measurements were obtained at selected locations around the Manning 34-E drill rig being operated by Texaco at a site approximately 11 miles north of Cody, Wyoming. Sound levels were obtained at this site for two reasons. The rig utilized by Texaco was similar to the rig proposed for the Amoco well. In addition, the general site conditions and topography around the Texaco site were sufficiently similar to the Rock Creek site to warrant noise comparison.

Measurement Procedure

The sound level data were obtained using a Bruel & Kjaer Type 2203 Precision Integrating Sound-level Meter and an analog strip chart recorder. The monitoring instrument was attached to a tripod and set at a height of 5 feet above the ground. The meter was calibrated three times daily using a Bruel & Kjaer Type 4230 Sound-level Calibrator. This equipment meets American National Standards Institute (ANSI) specifications (ANSI 1971).

Each measurement consisted of a 10-minute, A-weighted integration of noise levels for each monitoring location. In most cases, two of the measurements were obtained during daytime hours (0700-2200) with a third measurement taken during nighttime hours (0000 to 0700 and 2200 to 2400) (Von Gierke 1977). All data were recorded on standard forms. Extraneous identifiable noises heard by the operator during the measurement period were also recorded.

All data obtained during the monitoring program represent A-weighted sound levels (dBA). The A-weighted sound level is a weighting function applied to the sound spectrum which approximates the response of the human ear. The A-weighted level is a single-number measure of the magnitude of sound from 20 - 20,000 Hz, with a weighting characteristic which de-emphasizes lower frequencies of the noise spectrum (BLM 1982).

A-weighted sound levels, as obtained in the field, were converted to equivalent sound levels (Leq) for each ten-minute integrated measurement period. The Leq is obtained by averaging (on an energy basis) the A-weighted sound levels over a period of time; Leq is the continuous noise level in decibels that would be equivalent, in terms of sound energy, with the recorded fluctuating sound signal. The Leq may be calculated for each noise source.

To calculate the day-night average sound level (Ldn), A-weighted sound level data for a 24-hour period were averaged on an energy basis. All sound levels obtained during nighttime hours (0000 to 0700 and 2200 to 2400) were given a 10 dBA penalty due to the increased perception of noise during this period. As with the Leq values, Ldn values apply to all sources of noise (BLM 1985, VonGierke 1977).

TOPOGRAPHY

Topographic information was obtained from USGS maps of the well site and on-site inspection. Amoco provided a diagram of the proposed wellpad with cross-sections showing anticipated cut-and-fill requirements.

GEOLOGY

Geologic information was obtained from published data, information provided by Amoco, and site reconnaissance.

SOILS

The Carbon County Soil Survey did not include the well site. An on-site soil survey was completed using standard soil survey procedures (USDA-SCS 1975a). Each soil series identified on-site was excavated and systematically described on standard SCS soil survey forms. Samples were taken from each identifiable horizon and analyzed for their basic agronomic properties by a certified soil testing laboratory.

SURFACE WATER

Flow and water quality data for Rock Creek were obtained from published USGS records. Sediment production from disturbed areas was estimated using the Universal Soil Loss Equation (USEPA 1977) as follows:

$A = R*K*LS*C*P$ where,

A = Estimated soil loss in tons/acre,

R = Rainfall factor for June = 12.0 and September = 6.4,

K = Soil erodibility factor = 0.50,

LS = Slope-length factor = 1.2,

C = Cropping management factor = 1.0, and

P = Erosion control practice factor = 1.0.

GROUND WATER

Published and unpublished data were obtained to describe the existing environment. The effects of ground water pumping were estimated using the methods of Bear (1979). The worst-case analysis assumed: zero recharge from any source; a radius of influence of 1,500 ft.; and an effective porosity of 0.20.

AQUATIC ECOLOGY

Information for the aquatic ecology section was gathered from standard fishery sources, as summarized in Carlander (1969). Local information was gathered from the files of the Billings Office of the Montana Department of Fish, Wildlife, and Parks; interviews with Department fisheries personnel; and a site reconnaissance.

VEGETATION

Vegetation information was summarized from USFS planning documents; discussions with USFS and USFWS personnel; and a site reconnaissance.

WILDLIFE

Wildlife information was summarized from unpublished data provided by the Montana Department of Fish, Wildlife, and Parks personnel in Billings and Red Lodge; discussions with Department personnel and personnel from the USFWS; and site reconnaissance.

CULTURAL RESOURCES

Cultural resources information included in the EA was summarized from cultural resource investigations conducted by Powers Elevation, under contract to Amoco. The inventory included a file and literature investigation of the site vicinity and a detailed ground survey of the USFS lands included in the federal oil and gas lease. The private land on which the well would be located was intensively surveyed for cultural resources.

RECREATION

Recreation information was compiled from available State, County, and USFS planning documents and interviews with County, USFS, and BLM personnel. Existing data were collected on recreational opportunities; recreation use; and agency plans and policies regarding recreation. Quality of recreational experience was interpreted in a qualitative manner from available baseline data. Analysis of recreation impacts was conducted in close coordination with the visual analysis.

VISUAL RESOURCES

Visual resources information was collected using field reconnaissance and photographic evaluation during November 1985; interviews with USFS personnel; and review of existing USFS visual resource and planning data.

Methods

Visual Resource analysis methods were adapted from those of the U.S. Forest Service (1974) Visual Management System and BLM (1984a) Visual Resource Management System. Emphasis was placed on the Forest Service system because all of the existing data in the study area were collected in that format.

The major components of the visual inventory consist of:

- Regional landscape overview,
- Description of landscape units,
- Evaluation of visual variety,
- Identification of visual quality objectives (VQO's),
- Identification of Existing Visual Condition (EVC).

Baseline data were organized primarily by Landscape Unit based upon spatial and other distinct visual characteristics. Landscape Units are geographic areas with similar visual characteristics; the term is synonymous with the Scenic Quality Rating Unit used in the BLM's (1984a) Visual Resource Management System. Landscape units were evaluated for their scenic qualities or visual variety of landform, vegetation, water, ephemeral features, views of adjacent scenery, and cultural modifications (e.g., agriculture, roads, structures). Within the regional context of the Yellowstone Rockies Character Type, three levels of overall visual variety were used:

- Class A: Distinctive - outstanding or above average diversity of scenery.
- Class B: Common - diversity of scenery which occurs frequently within the region.
- Class C: Minimal - little or no diversity of natural scenery or adversely modified scenery.

Landscape units were also evaluated for existing visual condition, which is the present state of visual alteration measured in the extent of deviation from the naturally appearing landscape. EVC classes were defined by the USFS (1980) as shown in Table B-1.

TABLE B-1

EXISTING VISUAL CONDITION CLASSES

CLASS		DEFINITION
EVC 1	Untouched	Areas of ± 5000 acres in which only ecological changes have taken place, except for low impact rails and fences.
EVC 2	Unnoticed	Changes in the landscape are not visually evident to the average person unless pointed out. This also includes low visual impact 2-track trails and roads that may or may not be visible on most aerial photos.
EVC 3	Minor Disturbance	Changes in the landscape are noticed by the average person, but they do not attract attention. The natural appearance of the landscape still remains dominant. This includes developed pastures and roads and fields not associated with farmsteads.
EVC 4	Disturbed	Changes in the landscape are easily noticed by the average person and may attract attention. This includes cropland or highly developed hayfields (structural irrigation and canals). Well-designed oil fields are most always included, since their size and influence over the landscape is not entirely mitigable. The natural appearance of the landscape is definitely impacted in fields with well spacing at 160 acres or less.
EVC 5	Major Disturbance	Changes in the landscape are major and would be obvious to anyone. These changes stand out as a dominating impression of the landscape. Oil fields that are not designed or have no mitigating measures as well as other activities that have major landscape impacts are included.
EVC 6	Drastic Disturbance	Changes in the landscape are in glaring contrast to the natural appearance. Almost anyone would be displeased with the effect and agree that rehabilitation is required.

Visual sensitivity is defined as the level of user concern for visual change. High, Moderate, and Low levels of concern were identified, based on professional judgement and upon attitudes expressed in public meetings. Use-volumes were also considered, but user attitude was weighted more heavily than use-volume in determining visual sensitivity levels. High, Moderate, and Low levels of concern were considered equivalent to Sensitivity Levels 1, 2, and 3.

Key viewpoints were identified to represent the principal viewing situation in which the study area is seen, i.e., linear travel routes, residences, and recreation use areas. Distance zones from viewpoints were designated as:

Foreground - 0 to 1/2 mile
Middleground - 1/2 to 3-5 miles,
Background - 3 miles to infinity.

Visual Quality Objectives were defined by the U.S. Forest Service (1985) as follows:

P Preservation: This VQO allows ecological change only, except for very low visual impact recreation facilities. It applies to designated areas such as Wilderness.

R Retention: This VQO allows management activities which are not usually evident. Natural-appearing landscape remains dominant.

PR Partial Retention: This VQO allows for management activities which remain visually subordinate. The natural appearing landscape remains dominant. Changes in the landscape are evident but not dominant.

M Modification: This VQO allows management activities to dominate the natural-appearing landscape, although the change must be in harmony and balance with the elements of the landscape.

MM Maximum Modification: This VQO is the same as Modification, although it is only assigned to background viewing areas. Because of this, the magnitude of the change in natural appearing landscape

> can be greater than in Modification. The changes must be in harmony and balance with the landscape elements.

Visual impacts were addressed by describing visual contrasts introduced by the project, effects on existing visual condition, conformance with VQO's, and public perceptions. Visual Absorption Capability (VAC) data available from the U. S. Forest Service were not used because these are applied at a coarser level of resolution not suitable for detailed interpretation of specific projects.

Visual contrast is the result of physical characteristics of the project compared to its setting, and the visibility of the project from key viewpoints. Project characteristics were described in terms of scale, form, line, color, texture, and position, for landform, vegetation and structural components. Visibility was evaluated by field observation, including 360° photography from the hillside above the site, at an elevation which approximated the proposed height of the drill rig. Contrasts were described as strong, moderate, weak, or none. Based on contrast analysis, the future visual condition of the area was evaluated. The future visual condition was used to determine whether the VQO's for the area would be met.

LAND USE

A detailed land use inventory was completed to develop information for use by Envirosafe, Inc. in preparing the Health and Safety Contingency Plan. The inventory was prepared by interpreting aerial photographs (1982: 1 in. = 12,000 ft. and 1985: 1 in. = 24,000 ft.); review of records, maps, and subdivision plats made available by the Carbon County Assessor's, Appraiser's, and Sheriff's offices; and review of Special Use Permit information obtained from the USFS.

Evaluation of future land use was based on the Carbon County Comprehensive Plan, Carbon County Development regulations, Custer National Forest planning documents, and conversations with agency officials.

TRANSPORTATION

Data on average daily traffic levels and level of service standards for affected roadways were obtained from the Montana Department of Highways.

SOCIOECONOMICS

Social, economic, and community infrastructure data were obtained through personal interviews with officials from the USFS, Carbon County, and City of Red Lodge and review of available planning and economic data.

HEALTH AND SAFETY RISK ASSESSMENT

Introduction

This section describes the methodologies applied to quantify the human health and safety impacts of the proposed project. The impacts quantified were: 1) the 300 ppm, 100 ppm, and 15 ppm H_2S isopleths around the well site that could result from a horizontal and vertical blowout at the well head and, 2) the risk of an acute human health effect if a release occurred during the drilling period.

The COMPLEX I air quality dispersion model was used to predict H_2S concentrations. COMPLEX I was used because it takes into account the difference in elevation between the well source and each receptor. Model inputs were chosen to simulate the conditions of a wellhead blowout. The H_2S concentrations obtained were then used in the procedure developed by the Lawrence Livermore National Laboratory (LLNL) for the Division of Fluid Mineral Operations of the Bureau of Land Management and set forth in Accidental Releases of Sour Gas from Wells and Collection Pipelines in the Overthrust Belt: Calculating and Assessing Potential Health and Environmental Risks (LLNL 1983).

This application of air quality dispersion modeling extends beyond the intended applications for which the model was designed. While Dames & Moore has used conservative assumptions to estimate the realistic worst-case H_2S concentrations in the project area, actual concentrations experienced during a well blowout may be different than those estimated in this report.

Model Input Parameters

The parameters used to model a well blowout are presented in Table B-2. Flow rate and hydrogen sulfide percentage values were obtained from LLNL (1983). Ambient temperature used was the mean annual temperature for Red Lodge; this value was obtained from the Climatological Summary for Red Lodge. Ambient pressure was calculated using a formula listed in the LLNL (1983) report. Table B-2 shows two sets of input values. The average values reflect the most probable release characteristics based upon the LLNL survey of all wells drilled in the Overthrust Belt. The worst case values are the 95% upper confidence level of these values. The worst case values were actually used in the modeling analysis, indicating that there is a 95% chance that any blowout would be less severe than the blowout analysis presented here.

The types of well blowouts modeled were both vertical and horizontal releases. Stack parameters were chosen based on "worst case" and are presented in Table B-3.

Values for stack height, effective exit velocity and stack temperatures were assumed. Effective stack diameter was calculated by using well flow rate and effective exit velocity values. Stack height and vertical velocity were selected to force the model to calculate an effective plume height like that visibly displayed in photographs of the Lodgepole, Canada blowout.

The H_2S emissions rate is from LLNL (1983) and represents the upper bound of the 95 percent confidence limit of the geometric mean for a data set. This value of 6673 grams H_2S per second (g/s) is valid for vertical releases. To account for the increased resistance to flow in smaller pipe used on the surface, or at the bulkhead assembly, LLNL (1983) uses a first-order estimate of 40 percent of the calculated absolute open flow rate. The adjusted emission rate of hydrogen sulfide is 2669 g/s.

TABLE B-2

INPUTS TO THE WELL BLOWOUT ANALYSIS

PARAMETER	WORST-CASE VALUE	AVERAGE VALUE
Gas Flow Rate	60.0×10^6 SCF/day	4.7×10^6 SCF/day
H_2S content of gas	24 percent	6.9 percent
Ambient Pressure	813 mb	813 mb
Ambient Temperature	6°C (42°F)	6°C (42°F)

TABLE B-3

EFFECTIVE STACK PARAMETERS FOR THE WELL BLOWOUT DISPERSION MODELING

PARAMETER	HORIZONTAL RELEASE	VERTICAL RELEASE
Effective Stack Height	1.0 meters	45.0 meters
Effective Stack Diameter	1.4 meters	0.2 meters
Effective Exit Velocity	1.0 meter/second	60.5 meters
Exit Temperature	280°K (66°C)	280°K (66°C)
H_2S Emissions Rate[1]	2669 g/s	6673 g/s

[1] The 95% upper confidence limit, assuming a gas flow rate of 4.7 MMSCFD with an H_2S content of 6.9 percent.

The COMPLEX I model was run for a set of over 100 receptors around the proposed well site using a meteorological data set of 36 different meteorological conditions. The 36 conditions consisted of the midpoint of each wind speed class, 1-5, and lowest value on wind speed class 6 for each stability class (A-F). The highest H_2S concentration predicted at each receptor, regardless of meteorology, was used to draw the 300 ppm, 100 ppm, and 15 ppm H_2S isopleths about the proposed well site.

Calculation of Risk Estimate

The procedure followed to calculate the health risk at each receptor used in the COMPLEX I air quality dispersion model was taken from LLNL (1983). First, the H_2S concentration predicted for each meteorological condition at a receptor was evaluated to determine if it was greater than 300 ppm H_2S, the lowest concentration which would cause an acute response for a short averaging time (10 minutes). If the H_2S concentration was equal to or greater than 300 ppm, an Effect Probability of 1.0 was assigned; otherwise, the Effect Probability was 0.0. Next, the Effect Probability was multiplied by the frequency of occurrence of the meteorological conditions which produced the critical H_2S concentrations. The frequency of occurrence values used were from the Joint Frequency Distributions (JFD) for the Anaconda Stillwater Project mine site meteorology station which is located in a valley oriented similarly in direction to and located 35 miles northwest of the Rock Creek Valley (Anaconda 1981). The product of the Effect Probability and the JFD value is the health risk. The health risks for the 36 meteorological conditions at each receptor are added and the sum (cumulative health risk) is multiplied by the probability of a blowout (2.4×10^{-3}) to yield the total risk of an acute effect at a particular receptor (LLNL 1983).

APPENDIX C
GLOSSARY OF TERMS

ACIDIZE. To treat oil-bearing limestone or other formations, using a chemical reaction with acid, to increase production. Hydrochloric or other acid is injected into the formation under pressure. The acid etches the rock, enlarging the pore spaces and passages through which the reservoir fluids flow. The acid is held under pressure for a period of time and then pumped out, and the well is swabbed and put back into production. Chemical inhibitors combined with the acid prevent corrosion of the pipe.

ANNULAR BLOWOUT PREVENTER. A large valve, usually installed above the ram preventers, which forms a seal in the space between the pipe and wellbore or, if no pipe is present, on the wellbore itself.

BLOWOUT. An uncontrolled flow of gas, oil, or other well fluids into the atmosphere. A blowout, or gusher, occurs when formation pressure exceeds the pressure applied to it by the column of drilling fluid. A kick warns of an impending blowout.

BLOWOUT PREVENTER. One of several valves installed at the wellhead to prevent the escape of pressure either in the annular space between the casing and drill pipe or in open hole (i.e., hole with no drill pipe) during drilling or completion operations. Blowout preventers on land rigs are located beneath the rig at the land's surface; on jackup or platform rigs, they are located at the water's surface; and on floating offshore rigs, on the seafloor.

BOILER. Steam-generated heat for pits, rig floor, doghouse, BOPs, to keep critical components warm or from freezing-up.

BOP. Blowout preventer.

BOTTOMHOLE. The lowest or deepest part of a well. Pertaining to the bottom of the wellbore.

BULK MUD-COMPONENTS STORAGE. Area designated for storage of dry mud materials.

CASING. Steel pipe placed in an oil or gas well as drilling progresses to prevent the wall of the hole from caving in during drilling and to provide a means of extracting hydrocarbons if the well is productive.

CEMENTING. The application of a liquid slurry of cement and water to various points inside or outside the casing.

CHOKE HOUSE. Enclosure used to protect the valving used in restricting the flow of mud when circulating out a kick.

CHRISTMAS TREE. The control valves, pressure gauges, and chokes assembled at the top of a well to control the flow of oil and gas after the well has been drilled and completed.

CUTTINGS. The fragments of rock dislodged by the bit and brought to the surface in the drilling mud. Washed and dried samples of the cuttings are analyzed by geologists to obtain information about the formations drilled.

DIRECTIONAL DRILLING. Intentional deviation of a wellbore from the vertical. Although wellbores are normally drilled vertically, it is sometimes necessary or advantageous to drill at an angle from the vertical. Controlled directional drilling makes it possible to reach subsurface areas laterally remote from the point where the bit enters the earth. It involves the use of turbodrills, Dyna-Drills, whipstocks, or other deflecting tools.

DOGHOUSE. A small enclosure located on the rig floor and used as an office for the driller and as a storage place for small items; any small building used as an office or for storage.

DRILL BIT. The cutting or boring element used in drilling oil and gas wells. Most bits used in rotary drilling are roller-cone bits. The bit consists of the cutting element and the circulating element.

DRILL STRING. The column, or string, of drill pipe with attached tool joints that transmits fluid and rotational power from the kelly to the drill collars and bit. Often, the term is loosely applied to include both drill pipe and drill collars.

DRILLING FLUID. Circulating fluid, one function of which is to force cuttings out of the wellbore and to the surface. While a mixture of clay, water, and other chemical additives is the most common drilling fluid, wells can also be drilled using air, gas, or water as the drilling fluid. Also called Circulating Fluid and Mud.

EXISTING VISUAL CONDITION (EVC). The present state of visual alteration of the natural-appearing landscape by man-made objects. Five classes: (1) Untouched, (2) Unnoticed, (3) Minor Disturbance, (4) Disturbed, (5) Major Disturbance.

FORMATION FRACTURING. A method of stimulating hydrocarbon production by increasing the permeability of the producing formation. Under extremely high hydraulic pressure, a fluid (e.g., water, oil, alcohol, dilute hydrochloric acid, liquefied petroleum gas, or foam) is pumped downward through tubing or drill pipe and forced into the perforations in the casing. The fluid enters the formation and parts or fractures it. Sand grains, aluminum pellets, glass beads, or similar materials are carried in suspension by the fluid into the fractures. These are called propping agents or proppants. When the pressure is released at the surface, the fracturing fluid returns to the well, and the fractures partially close on the proppants, leaving channels for hydrocarbons to flow through them to the well. This process is often called a "frac job".

FUEL TANKS. Fuel storage.

HYDROCARBONS. Organic compounds of hydrogen and carbon, whose densities, boiling points, and freezing points increase as their molecular weights increase. Although composed only of two elements, hydrocarbons exist in a variety of compounds, because of the strong affinity of the carbon atom for other atoms and for itself. The smallest molecules of hydrocarbons are gaseous; the largest are solids. Petroleum is a mixture of many different hydrocarbons.

INTERMEDIATE CASING STRING. The string of casing set in a well after the surface casing, but before the production casing, to keep the hole from caving and to seal off troublesome formations. The string is sometimes called protection casing.

JUNK RACK. An area of the location, usually enclosed by a bin, which is used to store various components not needed after rigging-up is completed.

KICK. An entry of water, gas, oil, or other formation fluid into the wellbore. It occurs because the pressure exerted by the column of drilling fluid is not great enough to overcome the pressure exerted by the fluids in the formation drilled. If prompt action is not taken to control the kick or kill the well, a blowout will occur. See Blowout.

MAST. A portable derrick capable of being erected as a unit, as distinguished from a standard derrick that cannot be raised to a working position as a unit. For transporting by land, the mast can be divided into two or more sections to avoid excessive length extending from truck beds on the highway.

MUD. The liquid circulated through the wellbore during rotary drilling operations. In addition to its function of bringing cuttings to the surface, drilling mud cools and lubricates the bit and drill stem, protects against blowouts by controlling subsurface pressures, and deposits a mud cake on the wall of the borehole to prevent loss of fluids to the formation. Although it originally was a suspension of earth solids (especially clays) in water, the mud used in modern drilling operations is a more complex, three-phase mixture of liquids, reactive solids, and inert solids. The liquid phase may be fresh water, diesel oil, or crude oil and may contain one or more conditioners. See Drilling Fluid.

MUD PUMPS. Large, reciprocating pumps used to circulate the mud on a drilling rig. A typical mud pump is a double - or triple-acting, two- or three-cylinder, piston pump whose pistons travel in replaceable liners and are driven by a crankshaft actuated by an engine. A mud pump also may be called a "slush pump".

MUD TANK. A reservoir or tank, usually made of steel plates, through which the drilling mud is cycled to allow sand and fine sediments to settle. Additives are mixed with mud in the pit, and the fluid is temporarily stored there before being pumped back into the well.

PAY ZONE. The producing formation.

PERFORATE. To pierce the casing wall and cement to provide holes through which formation fluids may enter or to provide holes in the casing so that materials may be introduced into the annuals between the casing and the wall of the borehole. Perforating is accomplished by lowering into the well a perforating gun, or perforator, that fires electrically detonated bullets or shaped charges from the surface.

POWER-GENERATING PLANT. Source of power for the drilling rig.

PUMP HOUSE. Enclosure used to protect the mud pumps.

RAM BLOWOUT PREVENTERS. A blowout preventer that uses rams to seal off pressure on a hole that is with or without pipe. It is also called a ram preventer.

RESERVE PITS. Originally, a mud pit in which a reserve supply of drilling fluid was stored. Now the reserve pit is actually used as a waste pit and is usually an excavated, earthen-walled pit. If necessary, it may be lined with plastic to prevent contamination of the soil.

RIGGING UP. To prepare the drilling rig for making hole; to install tools and machinery before drilling is started.

SOIL STOCKPILE. Piles of surface soil and rocks stored for use in site restoration after drilling is completed.

SPUD IN. To begin drilling; to start the hole.

STIMULATION. Any process undertaken to enlarge old channels or create new ones in the producing formation of a well (e.g., acidizing or formation fracturing). See Acidize.

SURFACE CASING. The first string of any consequence that goes into a well is called "surface casing" because it is set deep enough to protect the well from cave-in of loose formations that are often encountered near the surface. It is the starting point for the casing head and other fittings that will be left on the completed well.

VISUAL QUALITY OBJECTIVES (VQO). Classification of the degree of acceptable alteration of the characteristic landscape based on physical and sociological characteristics of an area. Six classes are recognized in the USFS system: (P) Preservation, (R) Retention, (PR) Partial Retention, (M) Modification, (MM) Maximum Modification, (E) Enhancement.

VISUAL SENSITIVITY. The level of user concern for visual change in a landscape unit. Three levels are recognized: (1) High, (2) Moderate, (3) Low.

VISUAL VARIETY. The diversity of landscape character. Three levels are recognized: (1) Class A - Distinctive, (2) Class B - Common, (3) Class C - Minimal.

WALK. The ramp to the side of the drilling rig where pipe is laid out to be lifted to the derrick floor by the hoisting line; any elevated walkway (as a walkway on top of a tank battery).

WELL LOGGING. The recording of information about subsurface geologic formations. Logging methods include records kept by the driller, mud and cutting analyses, core analysis, drill stem tests, and electronic and radioactivity procedures.

WILDCAT. A well drilled in an area where no oil or gas production exists.

REFERENCES

American National Standards Institute (ANSI), 1971. American National Standards for accoustical terminology. ANSI, NY.

Amoco Production Company, 1986. Project information provided by Dave Brown, Amoco Production Company to Tom Shoemaker, Dames & Moore.

Anaconda, 1981. Anaconda Stillwater Project Data: Addenda to the 12-month environmental baseline report for air resources, ground water and vegetation.

Atwell, L. D. and W. B. Andrews, 1979. Risk assessment for sour gas facilities. Energy Resource Conservation Board, Calgary, Alberta, Canada.

Aylor, D., 1971. Noise reduction by vegetation and ground. J. Acoustical Soc. Amer. 51-1:197-205.

Bear, J. 1979. Hydraulics of groundwater. McGraw-Hill Publishing.

Bishop, G. G., 1967. Letter to James P. Ayling. Montana Fish & Game Department, Billings, MT.

Bureau of Land Management, 1981. Oil and gas environmental assessment of BLM leasing program, Lewistown District. BLM, Lewistown District, MT.

Bureau of Land Management, 1982. Guidelines for preparing noise impact analysis. Prepared by the Colorado State Office Staff of Planning and Environmental Coordination. In: Transportation and Noise Analysis Handbook, February 17, 1982.

Bureau of Land Management, 1983. Final environmental impact statement resource management plan, Billings area. BLM, Miles City District Office, MT.

Bureau of Land Management, 1984a. Interim guidance for visual resource management inventory and contrast rating. Instruction Memo 84-591.

Bureau of Land Management, 1985. North Fork Well final environmental impact statement. Bureau of Land Management, Worland District, WY.

Carlander, K. D., 1983. Handbook of freshwater biology, Volume 1. Iowa State University Press, Ames, IA.

Coffman, Jerry L. and Von Hake, Carl A., 1973. Earthquake history of the United States. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Publication 41-1.

Dalton, L. B., 1985. Big game movement and large diameter overland conveyance systems. Thorne Ecological Services Symposium on issues and technology in the management of impacted western wildlife. Glenwood Springs, CO. In press.

Dressler, R. L. and J. M. Bridges, 1981. Environmental impact analysis of Michigan hydrocarbon development. Report prepared for Amoco by Commonwealth Assoc. Inc.

Envirosafe, Inc., 1986. Draft contingency plan for the U.S.A. Amoco A#1. Envirosafe, Inc., Williston, ND.

Eppley, Robert A. and Cloud, William K., 1961. United States earthquakes, 1959. U.S. Department of Commerce, Coast and Geodetic Survey.

Espmark, Y. and R. Langvatn, 1985. Development and habituation of cardiac and behavioral responses in young red deer calves (Cervus elaphus) exposed to alarm stimuli. J. Mammal. 66:702-711.

Flath, D. L., 1985. Evaluation of techniques for recovery of peregrine falcons in Montana. Job progress report SE-1 job 2. Montana Fish, Wildlife and Parks Dept., Helena, MT.

Flath, D., 1986. Personal communication between Dennis Flath, Montana Department of Fish, Wildlife, and Parks and Harold Picton, Montana State University.

Foose, R. M., Wise, D. V., and Garbarini, G. S., 1961. Structural geology of the Beartooth Mountains: Montana and Wyoming. Geological Society of America Bulletin, 72.

Fredenberg, W. A., 1985. Personal communication between Wade Fredenberg, Montana Department of Fish, Wildlife, and Parks and Mike Busdosh, Affinis.

Fredenberg, W. A., S. E. Swedberg, and S. L. McMullin, 1985. South Central Montana Department of Fish, Wildlife, and Parks, Fisheries Division.

Goodwin, J. G., Jr., 1975. Big game movement near a 500 kV transmission line in northern Idaho. Western Interstate Commission for Higher Education study for the Bonneville Power Administration, Portland, OR.

Kruger, P., 1986. Personal communication between Paul Kruger, BLM Montana State Office and Tom Shoemaker, Dames & Moore.

Kuck, L., G. L. Hompland and E. H. Merrill, 1985. Elk calf response to simulated mine disturbance in southeast Idaho. J. Wildl. Manage. 49:751-757.

Lawrence Livermore National Laboratory, 1983. Accidental releases of sour gas from wells and collection pipelines in the overthrust belt: calculating and assessing potential health and environmental risks. Prepared for Division of Fluid Mineral Operations, Bureau of Land Management.

Lyons, L. J., T. N. Lonner, J. P. Weigand, C. L. Marcum, W. D. Edge, J. D. Jones, D. W. McCleerey, and L. L. Hicks, 1985. Coordinating elk and timber management. Montana Fish, Wildlife and Parks Dept., Helena, MT.

Montana Department of State Lands, 1977. Reclamation Division, Helena, MT.

Montana State Department of Highways, 1986. Data provided to Ken Kucera, Planning Information Corporation, January 1986.

Mueggler, W. F., and Stewart, W. L., 1980. Grassland and shrubland habitat types of western Montana. USDA for Serv. Gen. Tech. Rpt. INT-66. Intermt. Forest and Range Experiment Station. Ogden, UT.

Picton, H. D., J. Canfield and G. Nelson, 1986. North Boulder River elk study: 500 kV powerline impact. Report to the U. S. Forest Service, Deerlodge National Forest, Butte, MT. In preparation.

Powers Elevation, Archaeology Division, 1984. Cultural resource management report: Amoco Production Company; Rodgers Mountain Area Block Survey; Carbon County, MT.

Powers Elevation, Archaeology Department, 1985. Cultural resource management report: Amoco Production Company USA Amoco (A #1) Carbon County, Montana.

Qamar, A. I., and Stickney, M. C., 1983. Montana earthquakes, 1869-1979, Historical seismicity and earthquake hazard: Montana Bureau of Mines and Geology, Memoir 51.

Rickman, D. 1986. Personal communication between Dee Rickman, Montana Board of Oil and Gas Conservation, and Tom Shoemaker, Dames & Moore.

Schaller, G., 1985. Personal communication between George Schaller, USFS, Red Lodge and Stephen Sheppard, Dames & Moore.

Simmons, C. A., S. T. Stewart and T. W. Butts, 1983. Big game survey and inventory, deer and elk Region 5. PR report project W-130-R-14, Montana Fish, Wildlife and Parks Dept., Helena, MT.

Skaar, D., D. Flath and L. S. Thompson, 1985. P. D. Skaar's Montana bird distribution. Montana Acad. Sci. Vol. 44; Monograph 3.

Stewart S. T., 1986. Personal communication between Shawn Stewart, Montana Fish, Wildlife and Parks Department, and Harold Picton, Montana State University, in Billings, January 9, 1986.

U. S. Department of Agriculture, 1977. Beartooth Face planning unit background reports. Dakotas Planning Team.

U. S. Department of Agriculture, Soil Conservation Service, 1975a. Soil taxonomy, a basic system of soil classification for making and interpreting soil surveys, USDA handbook 436.

U. S. Department of Agriculture, Soil Conservation Service, 1975. Soil survey Carbon County area, Montana. U. S. Government Printing Office, Washington, D. C.

U. S. Department of Commerce, undated. Climatological Summary: Red Lodge, MT.

U. S. Energy Information Administration, 1984. Annual energy outlook. U. S. Energy Information Administration, Washington, D. C.

U. S. Environmental Protection Agency (USEPA), 1977. Preliminary guidance for estimating erosion on areas disturbed by surface mining activities in the interior western United States, Interim Final Report.

U. S. Forest Service, 1974. Visual Management System. National Forest Landscape Management Vol. 2., Chapter 1. Agriculture Handbook, No. 462.

U. S. Forest Service, 1978a. Beartooth Face management plan, Custer National Forest.

U. S. Forest Service, 1978b. Background reports for the Beartooth Face Planning Unit. U. S. Forest Service, Custer National Forest, Dickinson, ND.

U. S. Forest Service, 1980. Visual character types and variety class description. Northern Region.

U. S. Forest Service, 1981a. Beartooth Plateau interim management plan, FEIS.

U. S. Forest Service, 1981b. Visual management system field guide. Custer National Forest.

U. S. Forest Service, 1985. Draft Custer National Forest and National Grasslands land and resource management plan.

U. S. Geological Survey, 1981. Water resources data for Montana, USGS water data report, MT-75-1.

VonGierke, H. E., 1977. Guidelines for preparing environmental impact statements on noise. Sponsored by the Office of Naval Research. Code AD/A-044 384, June 1977. National Academy of Sciences.

Watson, M., 1986. Personal communication between Mark Watson, Wyoming Oil & Gas Commission, and Karen Watkins, Dames & Moore.

Witkind, I. J., 1975. Preliminary map showing known and suspected active faults in Wyoming. U. S. Geological Survey Open-File Report, OFR 75-279.